COMMENT DRAFT

NASA HISTORICAL NOTE

NASA AND THE SPACE SCIENCE BOARD OF THE NATIONAL ACADEMY OF SCIENCES

(HHN-62)

by

Charles M. Atkins

NASA Historical Staff
Office of Policy Analysis
National Aeronautics and Space Administration
Washington, D.C.
September 1966

NOT FOR RELEASE

FOREWORD

This is a NASA Historical Note examining the basic relationship which evolved between the Space Science Board of the National Academy of Sciences and the National Aeronautics and Space Administration. It is made available for validation and comment by those knowledgeable, and for limited reference use as the author helpfully discusses a unique relationship so important to the functioning of American science in the United States space program. While this Historical Note does not necessarily reflect the views of either the SSB or NASA, the author had privileged access to files and individuals for this study. No publication of this Comment Edition, therefore, is authorized without the express permission of the NASA and the Space Science Board. The NASA Historical Staff will welcome additive comment and/or criticism to support continued study and analysis.

Charles M. Atkins is currently continuing his graduate studies in science and public policy at the Massachusetts Institute of Technology. He received his B.A. degree from Dartmouth College, and his M.A. degree from Yale University, both with majors in physics.

Eugene M. Emme
NASA Historian

February 16, 1967

TABLE OF CONTENTS

PREFACE

The purpose of this paper is to examine the role of the Space Science Board of the National Academy of Sciences and, in particular, the Board's relationship with the National Aeronautics and Space Administration. In attempting to attain this objective, the paper has been divided into three sections. Part I is primarily concerned with the SSB--its advisory tasks, historical background, organization, and functions. The Board's relationship with NASA is reviewed more closely in Part II with special attention afforded to the manner of liaison between the two organizations. Finally, Part III considers the role of the Space Science Board as a representative of the scientific community.

This paper has been written in conjunction with the NASA Summer Seminar entitled "History, Social Science, and Space." In this regard, acknowledgement must be conferred to Dr. Eugene M. Emme and Dr. Frank W. Anderson of the NASA Historical Staff, for their suggestions and guidance. Furthermore, particular appreciation must also be expressed to Dr. Hugh Odishaw, Executive Director of the Space Science Board, for his generous consent to employ the files of the Board in this study.

CMA

INTRODUCTION

The field of science and public policy is a relatively recent one; its initial recognition, academically, is usually attributed to Don K. Price's Government and Science, first published in 1954. Since that time--between the birth of the nuclear age and the dawn of the space era--science has become inextricably entwined in the affairs of government. The results have sometimes been disheartening, and a number of publications have appeared concerning the responsibility of the scientific community and its proper role in today's technological society.[1]

The Space Science Board serves, in this respect, as an excellent example of the successful utilization of scientific advice fastidiously obtained from a well-informed group of experts representing the scientific community. As such, both NASA and the Board are to be congratulated for their judicious endeavors to establish a balanced program of scientific research in space at a time when politicians and

---

[1] See for instance the writings of A. Hunter Dupree, Robert Gilpin, Robert Jungk, Ralph Lapp, Eugene Rabinowitch, and Dael Wolfle (to name a few) in addition to others mentioned in this paper.

academicians are still attempting to ascertain the demise of the scientific estate.[2]

To be sure, the proceedings of the Space Science Board evoke criticism even within the scientific community, which is itself endeavoring to achieve an equilibrium with society. Some of these critical reviews are based on reasonable assertions and attempt to be objective, while others are often the illogical statements of a scientific establishment groping for an understanding of its new functions.

An example of the former is a report, by the AAAS Committee on Science in the Promotion of Human Welfare, entitled The Integrity of Science. This Committee, chaired by Dr. Barry Commoner of Washington University, established a solid foundation for discussing the functions of a scientific advisory group:[3]

> ...the ultimate source of the strength of science will not be found in its impressive products or in its powerful instruments. It will be found in the minds of scientists, and in the system of discourse which scientists have developed in order to describe what they know and to perfect their understanding of what they have learned.

---

[2]See for example: Don K. Price, The Scientific Estate (Cambridge: Harvard University, 1965).

[3]American Association for the Advancement of Science, The Integrity of Science, A Report by the AAAS Committee on Science in the Promotion of Human Welfare, December 31, 1964, p. 1.

This premise was amplified further in the Commoner Report, which also cited the Apollo recommendations of the Space Science Board as being, in its opinion, inimical to the 'integrity of science.'[4] NASA and the Space Science Board of the National Academy of Sciences does not attempt to examine the rationality of such arguments. Nor does the scope and purpose of the paper warrant involvement in such controversial and subjective discussions. However, this document does strive to present an objective analysis of the role of the Space Science Board. It is hoped, furthermore, that this review will adequately delineate the activities of this organization, thereby eliminating any confusion surrounding the functions of the SSB.

A number of authors have, in fact, revealed that some aspects of not only the Government but also the scientific community are misinformed about the role of the Space Science Board. Donald W. Cox, for instance, in an effort to investigate some crucial decisions affecting the nation's space effort, incorrectly states one task that the Board has performed:[5]

> ...our top space officials have suddenly felt the need to obtain some outside positive scientific advice to help them chart the nation's course in space after 1970. So four years after the birth of NASA, they requested the National Academy of Sciences to help them with the task...

---

[4]D. S. Greenberg, "Space: Administration Official Says Some Harsh Things About Scientists Opposing Moon Landing," Science, January 22, 1965, p. 381.

[5]Donald W. Cox, America's New Policy Makers: The Scientists' Rise To Power (New York: Chilton Books, 1964), pp. 153-154. (Underline added by author).

Another example is furnished by Ralph Lapp, a prominent scientist well known for his studies of the involvement of science in public policy. In his book, The New Priesthood, Dr. Lapp asserts that the Board was established in 1959,[6] while the actual date was in the middle of 1958! Such mistakes, although by no means demonstrating that other statements are erroneous, do tend to cause one to doubt the validity of an author's conclusions. In any case, such writers reveal a definite lack of knowledge of the role of the Space Science Board--a deficiency which this paper endeavors to rectify.

---

[6]Ralph E. Lapp, The New Priesthood: The Scientific Elite and The Uses of Power (New York: Harper and Row, 1965), p. 169.

PART I. THE SPACE SCIENCE BOARD

CHAPTER I - ADVISORY ROLE

> The challenges of space are many, and they are perceived in various ways by different men. To a few, space activity may be no more than a spectacular pyrotechnical exhibition, unmatched by the fireworks of holidays. To others it is man's supreme adventure, dwarfing the challenge of Mount Everest and rooted in old yearnings recited in myth and history. The practical man recognizes that a large new industrial complex has quickly come into being, and he sees its applications in communications, weather forecasting, navigation, and mapping. The engineer is engrossed in the development of space systems having ever greater power and efficiency. The scientist, looking at space vehicles as carriers of measuring devices, seeks to probe far beyond the earth for new knowledge of the nature of the universe. Men concerned with political affairs see space, by virtue of its planetary and transplanetary nature, as a logical arena for co-operation among men and nations, but they also see new problems both in its military applications, and in the power of space tools to affect man's physical environment.

This statement by Dr. Hugh Odishaw,[1] which introduces one of the foremost books on scientific research in space, may also be employed to establish the raison d'etre of the Space Science Board of the National Academy of Sciences. The Academy itself is "a private organization of scientists and engineers that serves as an official adviser to the Federal Government."[2] The Space Science Board conducts these advisory services involving scientific aspects of the national space program.

---

[1] Hugh Odishaw (ed.), The Challenges of Space (Chicago: University of Chicago, 1962), p. ix.

[2] Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1964, Washington, p. 93.

In addition, the Board acts as the international liaison, on behalf of the NAS, in the field of space research. Thus, the SSB is confronted with the formidable task of representing the interests of the U.S. scientific community in the realm of what is often termed space science.

Domestically, the Space Science Board serves in an advisory and consultative capacity to "agencies of the Federal Government having executive responsibilities in the field of space science."[3] These agencies are primarily the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and the Department of Defense (DOD). The Board has also provided some advice to other governmental agencies, such as the Federal Communications Commission on the "requirements for allocation of radio frequency bands to meet special research requirements."[4]

Internationally, the Space Science Board functions as the national means, through the National Academy of Sciences, for cooperation with scientists of other countries. The Board represents the U. S. scientific community on the Committee on Space Research. This committee, known as COSPAR, is part of the International Council of Scientific Unions (ICSU). The Committee on International Relations of the Space Science Board, whose chairman serves as the Academy's delegate to COSPAR, provides "adherence to COSPAR."[5]

---

[3] Ibid., 1961, p. 67.

[4] Ibid., 1960, p. 61.

[5] Ibid., 1961, p. 67.

The Space Science Board has a considerable influence on the development of the national space program. Appendix A represents a tabulation of some of the principal tasks completed by the Board for the period 1958-1961. The importance of the SSB can be gathered from the following, more general accomplishments for the same period of time:[6]

1) aided in the transition from the IGY to the NASA program
2) interested the scientific community in scientific research in space
3) advised in the formulation of a more definitive U.S. space program
4) helped in the reorganization of NASA.

Although the Board has accomplished a number of valuable tasks, which alone justify its existence, the importance of the SSB is manifest for even more substantial reasons.[7] For one, with such a large scientific research program in space, it is deemed necessary to obtain the advice of a responsible and well-organized group of scientists who are themselves independent of government. This group must not only be representative of the scientific community but also be receptive to the demands of the scientists. It is apparent that such a body of scientists best resides within a private organization such as the National Academy of Sciences.

---

[6]Memorandum from Lloyd Berkner, Chairman, Space Science Board, Washington, D. C., January 5, 1962, p. 1.

[7]Interview with James E. Webb, Administrator, National Aeronautics and Space Administration, September 9, 1966.

The need for such a group within the Academy is further justified by the international obligations of the Academy to such organizations as the ICSU.[8]

These reasons are adequately summarized in a letter to the President of the National Academy of Sciences from the Board's first chairman, Dr. Lloyd V. Berkner:[9]

> Let me say here that I am convinced that the Board is most important for three reasons: first, the government needs the type of advice that only the Academy can provide; second, the scientific community needs a mechanism to express its views, and here again I believe that the Academy provides the most effective institution for this purpose; and, third, I believe that the Board's activity is crucial in the field of international cooperation, particularly within the ICSU-COSPAR framework.

The public, which plays an important role itself in conjunction with the scope and direction of the national space program, represents another factor to be reckoned with by the Space Science Board. Generally, the American people expect certain spectacular achievements to be accomplished in space, such as manned landings on the moon or planets. Yet, it must be realized that a substantial amount of scientific research is an important part of space exploration.

The Board must, therefore, cope with the problem of making certain that the space program involves basic scientific objectives, which are at the same time acceptable to the public. This involves informing the American people of the necessity of these objectives. Consequently, the

---

[8]Memorandum from Lloyd Berkner, Chairman, Space Science Board, Washington, D. C., January 5, 1962, pp. 1-2.

[9]Letter from Lloyd Berkner, Chairman, Space Science Board, Washington, D. C., August 24, 1962.

Board has attempted not only to represent the interests of science, but also to orient the public toward these goals. In other words, the Board endeavors to recommend a scientific program in space that is publicly acceptable.[10]

The National Aeronautics and Space Administration has provided full financial support of the Space Science Board since 1964. Up until that time, the Board's support had been by contract between the National Academy of Sciences and the National Science Foundation which shared the financing equally with NASA:[11]

> In 1964, at the request of the National Science Foundation, NASA provided the support for the Board's operation and the Academy's annual contribution to the international space organization, the Committee on Space Research.

The Space Science Board had been jointly supported until 1964 by these two institutions "because NASA and NSF have primary responsibility for civilian space science, [so that] the relations of the Board to these agencies have been particularly close."[12] However, the National Science Foundation has not participated, to any great extent, in the exploration of space since the International Geophysical Year when it supported the

---

[10]Letter from Lloyd Berkner, Chairman, Space Science Board, Washington, D. C., July 16, 1962.

[11]Proposal for Support of the Space Science Board for the Period December 1, 1965 - November 30, 1966, October 28, 1965, p. 1.

[12]United States Aeronautics and Space Activities, 1960, p. 57.

Vanguard project. During the IGY the National Science Foundation helped support the high-altitude sounding rocket program, which has been continued primarily by NASA. Recently, the development of a space telescope, in conjunction with the Kitt Peak National Observatory, has been the principal space activity of NSF, which actively supports astronomy.[13]

The fact that NSF has played only a minor role in space research, compared to NASA, would appear to justify the fact that NASA has assumed full financial support of the Board. The Space Science Board anticipates that NSF interests in space research will grow, particularly in astronomy as well as in rocket research in the upper atmosphere.[14]

Likewise, the Board has strived to increase the participation of the Department of Defense in scientific research in space. There is some interaction between the Board and DOD, although understandably the Space Science Board is not involved in DOD affairs to the extent that it is with NASA. Basically, the reason is that the Department of Defense, by its very nature, must focus on military applications of space technology rather than pure scientific research.[15]

These broad advisory roles of the Space Science Board, which have been briefly mentioned, indicate that the Board plays an important role in the

---

[13] Odishaw, p. 170.

[14] Interview with Hugh Odishaw, Executive Director, Space Science Board, August 2, 1966.

[15] Dr. Harry Hess, Statement Before the Committee on Aeronautical and Space Sciences, U. S. Senate, August 25, 1965.

national space effort. Furthermore, besides these overt domestic and international activities, the Board serves science in even more general ways.[16]

> It provides a focus for the interests of American science and a voice for the scientific community.

With this introduction, into the functions of the Space Science Board of the National Academy of Sciences, the stage is set for a more detailed analysis of the Board. But first it is necessary to investigate the historical roots of these functions, which are found in the International Geophysical Year.

---

[16]Hugh Odishaw and Lloyd Berkner (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 429.

CHAPTER II - HISTORICAL ROOTS

The International Geophysical Year had two direct antecedents involving scientific cooperation among nations: the First Polar Year in 1882-83 and the Second Polar Year fifty years later, in 1932-33. This established a precedent for convening such international polar years every half-century. However, in 1950, a suggestion arose that the next polar year be conducted during 1957-58, that is, after a twenty-five-year interval. The scientists who supported this change advanced the following reasons:[1]

1) the need for more basic data.
2) the rapid development of new communications systems.
3) the fast progress of supersonic means of travel.
4) the prediction of unusual activity on the surface of the sun during 1957-58.

The proposal, which originated in Washington, D. C. was agreed upon ultimately by the international scientific community. In 1952, the International Council of Scientific Unions enlarged the extent of the polar year in order to encompass the entire earth. The National Academy of Sciences, which represents the United States in the ICSU, formed, in February 1953, the United States National Committee for the International

---

[1] U. S. Congress, Senate, Committee on Aeronautical and Space Sciences, Documents on International Aspects of the Exploration and Use of Outer Space, 1954-1962, Senate Document No. 13, 88th Cong., 1st Sess., 1963, pp. 2-3. Cited hereafter as International Documents.

Geophysical Year and assigned it the task of directing America's role in the IGY.[2]

It became apparent, as preparations were being made, that the Federal Government would have to supply the necessary funds for the United States effort. An accord was reached whereby the National Academy of Sciences would be amenable for completing the scientific aspects of the program, while the National Science Foundation would supply the financial support.[3] This arrangement was further extrapolated when President Eisenhower endorsed a recommendation by the National Committee for the IGY regarding an earth satellite program; the Academy was entrusted with the scientific responsibility, while NSF was accorded with the fiscal responsibility.[4]

The National Committee for the IGY organized a number of panels in a variety of areas, among which was the Technical Panel on the Earth Satellite Program. On December 5, 1956, the National Committee requested the Satellite Panel to investigate "a continuing program of scientific research using earth satellite vehicles."[5]

---

[2] Ibid., p. 3.

[3] This agreement would appear to establish the precedent for the pecuniary support of the Space Science Board by NSF at first.

[4] International Documents, p. 3.

[5] Letter from Richard Porter to the Chairman, USNC-IGY, January 8, 1957 (underline added by author).

Since it was indicated that a report on this study be available not later than January 10, 1957, a temporary group--rather than the entire Satellite Panel--was formed at first, to study this recommendation. The program, as proposed by Dr. Lloyd Berkner, was to consist of about thirty attempted launches over a five-year period. This ad hoc task force included Dr. Van Allen, Dr. Newell, Dr. Kellogg, Dr. Rosen, and Dr. Spitzer--some of whom were to play an important role in the formation of the Space Science Board.[6]

The launching of SPUTNIK I by the Soviet Union in October of 1957 increased the tempo of concern over scientific research in space by the United States. It became apparent, as more satellites were placed in orbit, that both the U. S. and the U.S.S.R. would continue to launch additional ones even beyond the period of the IGY. The impetus was felt to assure that "full advantage be taken of these vehicles for scientific study."[7]

Thus, as U. S. space research efforts became discernible the Academy's IGY Committee realized the necessity of developing a sound scientific program regarding the exploration of space. First of all, it was important that scientific research in space be established on a wide scale throughout the U. S. scientific community. This would entail involving universities and industry in order to assure a solid foundation for the emerging space program. Furthermore, the National Committee

---

[6] Ibid.

[7] Letter from Hugh Odishaw, Executive Director, Space Science Board, June 12, 1958.

concluded: "The future of many areas of fundamental scientific research appeared inextricably entwined with space development."[8]

Dr. Hugh Odishaw, who later assumed the responsibility of Executive Director of the Space Science Board, communicated the National Committee's position on rocket and satellite research to the President of the National Academy of Sciences, Dr. Detlev Bronk. It was reported that the Department of Defense was considering post-IGY satellite research and that along with any civilian scientific programs for satellites there might be a need for advice from the Academy. In this letter, dated December 24, 1957, Dr. Odishaw stated:[9]

> The proposal for an Academy committee in this area was based on its value in terms of its representation of the views of American scientists and in view of possible sustained interest in this area by I.C.S.U.

Before the close of the IGY,[10] similar concerns over the continuity of scientific work in space were expounded, in particular by the Director of the National Advisory Committee for Aeronautics, Dr. Hugh L. Dryden, and the Director of the National Science Foundation, Dr. Alan T. Waterman. These Government officials thus expressed their interest in the establishment, by the Academy, of what was to become the Space Science Board. This recommendation was further augmented by the knowledge that the ICSU expected

---

[8]Space Science Board, Report of Activities, June 1958-June 1959, Washington, D. C., p. 1.

[9]Letter from Hugh Odishaw, Executive Director, USNC-IGY, December 24, 1957.

[10]The International Geophysical Year was held from July 1, 1957, to December 31, 1958.

to establish the Committee on Space Research, which would necessitate participation by the Academy in the field of scientific research in space along international lines.[11]

Hence, the notion of a Space Science Board was originated by scientists--even before the first earth satellite was launched by the Russians. These scientists subsequently aroused the interest of the Federal Government until formation of the Board was proposed to the NAS President, by the Directors of the National Science Foundation, the National Advisory Committee for Aeronautics, and the Department of Defense's Advanced Research Projects Agency.[12]

---

[11]Lloyd Berkner and Hugh Odishaw (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 429.

[12]Space Science Board, Report of Activities, June 1958 - June 1959, Washington, D. C., p. 11.

CHAPTER III - SSB ESTABLISHMENT

The Space Science Board was formally established in June of 1958 by the National Academy of Sciences to "advise and assist in [the] formulation of [a] U.S. post-IGY space research program and to foster cooperation with space scientists in other nations."[1] The following telegram, signed by Dr. Detlev Bronk, President of the National Academy of Sciences-National Research Council, was sent to prospective SSB members on June 4, 1958:

> THE NATIONAL ACADEMY OF SCIENCES IS ESTABLISHING A SPACE SCIENCE BOARD TO STIMULATE AND AID SUCH RESEARCH, TO EVALUATE PROPOSED RESEARCH, TO RECOMMEND RELATIVE PRIORITIES FOR USE OF SPACE VEHICLES FOR SCIENTIFIC PURPOSES, TO GIVE SCIENTIFIC AID TO THE PROPOSED NATIONAL AERONAUTICS AND SPACE AGENCY, THE NATIONAL SCIENCE FOUNDATION AND THE DEPARTMENT OF DEFENSE AND TO REPRESENT THE ACADEMY IN INTERNATIONAL COOPERATION IN SPACE RESEARCH. I HOPE VERY MUCH THAT YOU WILL AGREE TO SERVE AS A MEMBER OF THIS BOARD UNDER THE CHAIRMANSHIP OF LLOYD BERKNER. ALAN WATERMAN OF THE SCIENCE FOUNDATION, HERBERT YORK OF DEPARTMENT OF DEFENSE AND DR. KILLIAN'S OFFICE AGREE WITH ME THAT THIS BOARD WILL SATISFY A PRESSING NEED FOR THE FORMULATION AND GUIDANCE OF SUITABLE AND ADEQUATE PROGRAMS IN THIS IMPORTANT FIELD. YOUR EARLY ACCEPTANCE WOULD BE APPRECIATED. PLEASE WIRE COLLECT.

Subsequently, on August 2, 1958, Dr. Bronk announced the formation of the 16-member Board, "to survey in concert the scientific problems, opportunities and implications of man's advance into space."[2]

---

[1] Eugene Emme, Aeronautics and Astronautics, 1915-1960 (Washington: National Aeronautics and Space Administration, 1961), p. 99.

[2] Public Statement from the National Academy of Sciences, National Academy of Sciences Establishes Space Science Board, August 3, 1958, p. 1.

Dr. Lloyd Berkner, President of Associated Universities, Inc., President of the International Council of Scientific Unions, and a member of the National Academy of Sciences, was appointed Chairman. Dr. Hugh Odishaw, Executive Director of the U.S. National Committee for the IGY, was named as Executive Director of the new Board. It was also planned to recruit a permanent staff to serve as Secretariat. Furthermore, at the time of Dr. Bronk's announcement, eleven ad hoc committees had already been organized to conduct the work of the Board.[3]

The Board was originally assigned the task of advising Government agencies on "a vigorous and balanced program in space science" and assisting in the establishment of "working relationships" between civilian science and that of federal agencies. It was also envisioned to provide "a channel for scientific cooperation" along international lines and to assist in the "consideration of immediate and long-range effects" of scientific research in space.[4]

In making the announcement, Dr. Bronk reiterated the functions of the Board and thereby furnished its charter which was originally

---

[3] Ibid., p. 1 and p. 3. See also Appendix B for these original committees together with their chairmen and vice-chairmen who comprise the membership of the Board.

[4] National Aeronautics and Space Administration, First Semiannual Report to the Congress (Washington: National Aeronautics and Space Administration, 1959), p. 39.

contained in a letter to Dr. Berkner on June 6, 1958, acknowledging his acceptance of the chairmanship of the new Space Science Board:[5]

> ...It is my hope that the Board will give the fullest possible attention to every aspect of space science, including both the physical and the life sciences I believe that we have a unique opportunity to bring together scientists from many fields to survey in concert the problems, the opportunities, and the implications of man's advance into space, and to find ways to further a wise and vigorous national scientific program in this field.
>
> We have talked of the main task of the Board in three parts - the immediate program, the long-range program, and the international aspects of both. In all three we shall look to the Board to be the focus of the interests and responsibilities of the Academy-Research Council in space science; to establish necessary relationships with civilian science and with governmental scientific activities, particularly the proposed new space agency, the National Science Foundation, and the Advanced Research Projects Agency; to represent the Academy-Research Council in our international relations in this field on behalf of American science and scientists; to seek ways to stimulate needed research; to promote necessary co-ordination of scientific effort; and to provide such advice and recommendations to appropriate individuals and agencies with regard to space science as may in the Board's judgment be desirable.
>
> As we have already agreed, the Board is intended to be an advisory, consultative, correlating, evaluating body and not an operating agency in the field of space science. It should avoid responsibility as a Board for the conduct of any programs of space research and for the formulation of budgets relative thereto. Advice to agencies properly responsible for these matters, on the other hand, would be within its purview to provide...

Thus, six months after the first U. S. earth satellite, EXPLORER I, was launched with the IGY scientific experiment of Dr. Van Allen, the

---

[5]Letter from Dr. Detlev Bronk, President, National Academy of Sciences, Washington, D. C., June 26, 1958. See Appendix C for this letter from Dr. Bronk to Dr. Berkner.

Space Science Board was established as a successor to the NAS Panels on Rocket and Satellites of the IGY. Hence, the Board was able to draw on the experience of the panels not only in regard to manpower but also in terms of recommendations. At the first meeting of the Board on June 27, 1958, Dr. Bronk expressed his desire that the SSB:[6]

> provide for an orderly extension and continuation of the rocket and satellite work of the USNC/IGY... Continuity of [the] Program would be insured through common membership of R. W. Porter, Chairman of the Technical Panel for the Earth Satellite Program and ...through members of the Secretariat.

At this meeting Dr. Berkner, the new Board's chairman, introduced the SSB to some of its tasks:[7]

1. Encourage participation of scientists from universities and institutions outside of government to ensure U.S. space science development on a broad base. While government participation was essential, it would be unwise for space science to develop entirely within the bounds of government activity. Consequently, the Board must encourage initiative outside the bounds of government laboratories.

2. Provide guidance to scientific endeavor in the field of space science, encouraging the participation from all fields of science, guiding integration of similar proposals, and eliminating that which is inappropriate. He noted that these functions would be best provided by a board broadly representative of U.S. science outside direct government channels.

3. Be aware of the military and commercial aspects of space science as well as the purely scientific.

   He listed as primarily military applications: reconnaissance, intelligence and communications - jamming activities; and as an example of commercial application, the use of satellites as communication and TV links. He

---

[6]Minutes of the First Meeting, Space Science Board, June 27, 1958, pp. 2-3.

[7]Ibid., p. 3.

pointed out the effect that would be produced on the other two by pure science use. Chairman Berkner made clear that the launching of a space vehicle has become an international symbol of scientific success and strongly influences a desire for co-operation. As an example, he mentioned the IGY which had a tremendous effect on international relations.

4. Work to prevent contamination of moon and planets.

   Through ICSU and other international bodies, obtain recognition of the problem, and prevent irresponsible or unnecessary contamination of moon and planet surfaces and atmosphere.

5. Work with government space agencies.

   Provide advice, guidance and assistance to all government space agencies to aid in development of effective space science programs and experiments.

A more comprehensive description of the scope of the Board's functions is contained in the original contract entered into by the National Science Foundation and the National Academy of Sciences. Contract NSF-C100, effective as of September 1, 1958, provided that the work of the Space Science Board would "include, but not necessarily be limited to the following":[8]

(1) Maintain an active interest in every aspect of space science including the physical and life sciences.

(2) Bring scientists together from many fields to survey in concert the problems, implications, and opportunities of man's advance in space.

(3) Advise the Foundation, the National Aeronautics and Space Administration, and other Federal agencies as may be mutually agreed upon, on a wide and vigorous national program in space science.

(4) Consider both the immediate and long range program of space science and the international aspects relating thereto.

---

[8]National Science Foundation, Contract NSF-C100, pp. 1-2.

(5) Establish necessary liaison and working relationships with civilian science and with governmental scientific activities; and provide a channel for scientific cooperation in international space research activities.

(6) Supply information for dissemination by the Foundation and the National Aeronautics and Space Administration to present and prospective grantees regarding opportunities for research in space science.

(7) Provide the National Aeronautics and Space Administration and the Foundation with assistance and advice, when requested, in any phase of research.

(8) Carry out such activities in this area as may be mutually agreed upon by the Foundation and the Contractor [the National Academy of Sciences].

The Board, immediately upon its establishment, sought proposals and suggestions from a broad cross section of the national scientific community for projects to continue scientific research in space carried on during the IGY. The Space Science Board was keenly aware of the necessity for developing a program of space research which would provide a systematic extension of the rocket and satellite work of the U. S. National Committee for the IGY.[9]

At its first meeting after Dr. Berkner had introduced the Board to some of its tasks, reports on the current and projected status of the national space program were presented by: Dr. Richard Porter, representing USNC/IGY; Dr. Herbert York, representing ARPA; Dr. Hugh Dryden, representing NACA; Dr. Alan Waterman, representing NSF; and Dr. Hugh Odishaw, representing

---

[9]Lloyd Berkner and Hugh Odishaw (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 82.

NAS. The Board then assigned its Committee on Immediate Problems, chaired by Dr. Porter, the task of developing a prompt program of scientific research projects:[10]

> Dr. Berkner emphasized the importance of Dr. Porter's committee, and stated that he would like to see from Dr. Porter a proposal for an immediate program, within one month or six weeks. This program is to include recommendations for specific experiment packages and satellites over the next two years. The other committees must develop experimental programs geared to achieve results in three to five years; but, inevitably, they must also assist Dr. Porter in unravelling the immediate problems in their respective fields.

Dr. Porter approached this assignment by requesting the aid of the other Board members and their respective committees on fifteen specific experiments, while at the same time planning to collect proposals for the second meeting of the Board.[11] In order to transact the latter plan, Dr. Porter, with several associates from the Satellite Panel of the National Committee, "attempted to outline a continuing program of specific experiments relating ... to space science... ."[12]

For this purpose, early in July 1958, over 150 telegrams were sent to a large number of scientists and research laboratories throughout the

---

[10]Minutes of the First Meeting, June 27, 1958, Space Science Board, pp. 4-11.

[11]Ibid., pp. 12-13.

[12]Letter from Dr. Richard Porter, Chairman, Committee on Immediate Problems, Space Science Board, Washington, D. C., July 18, 1958.

United States. These messages requested proposals for experiments dealing with scientific research in space to be conducted with earth satellites and high altitude rockets. Some 100 suggestions were received from the scientific community, as a result of the following telegram:[13]

> ACADEMY HAS BEEN ASKED BY GOVERNMENT TO ASSESS POSSIBLE EXPERIMENTS THAT MIGHT BE DESIGNED AND CONSTRUCTED FOR SATELLITE FLIGHTS DURING NEXT TWO YEARS. THIS IS ADMITTEDLY A PRELIMINARY STUDY BUT COULD LEAD TO SUPPORT OF SOME EXPERIMENTS IN NEAR FUTURE. APPROXIMATE PAYLOAD PER FLIGHT PERHAPS AS HIGH AS HUNDRED POUNDS AND WITHIN THIS LIMIT SEVERAL SMALLER NON-CONFLICTING EXPERIMENTS MIGHT BE ACCOMMODATED. SHOULD APPRECIATE YOUR ASSISTANCE AND FOLLOWING INFORMATION AIRMAIL WITHIN ONE WEEK. DO YOU OR YOUR COLLEAGUES HAVE EXPERIMENT(S) THAT COULD BE DEVELOPED TO POINT OF FINAL ENVIRONMENTAL TEST BY MID-1959 OR EARLIER. IF SO, PLEASE PROVIDE FOLLOWING INFORMATION ON EACH PROPOSED EXPERIMENT. FIRST, SEVERAL PARAGRAPHS DESCRIBING EACH EXPERIMENT, ITS SCIENTIFIC VALUE, AND THE PROPOSED INSTRUMENTATION. INCLUDE ESTIMATED WEIGHTS. SECOND, PROVIDE BEST POSSIBLE ESTIMATE OF TOTAL COSTS FOR DESIGN AND CONSTRUCTION OF FOUR COMPLETE HARDWARE UNITS, FLIGHT LIAISON PERSONNEL, DATA REDUCTION AND ANALYSIS. THIRD, PROVIDE ESTIMATE OF MONTHS REQUIRED BETWEEN GRANTING OF FUNDS AND COMPLETION OF HARDWARE. REGRET NEED TO ASK FOR SUCH INFORMATION ON SO SHORT NOTICE BUT CANNOT AVOID.

The initial screening of proposals involving satellites or space probes was assigned to Dr. Porter, while those concerned with high altitude sounding rockets were allotted to Dr. Van Allen.[14] Dr. Porter combined these suggestions with material already available to the Satellite Panel as well as his own personal knowledge. The result was a report dated July 18, 1958, distributed at the second meeting of the Space

---

[13]Minutes of the Second Meeting, July 19, 1958, Space Science Board, p. 2; telegram from Dr. Lloyd Berkner, Chairman, Space Science Board, Washington, D. C., July 3, 1958.

[14]Space Science Board, Report of Activities, June 1958 - June 1959, Washington, D. C., p. 3.

Science Board. This paper was presented as a preliminary compilation of proposed experiments for a short-range program (1958-60) of scientific research utilizing, for the most part, satellites.[15]

The Space Science Board, at its second meeting, reviewed the reports submitted by Dr. Porter and Dr. Van Allen. The result was that six satellite experiments were chosen by the Board for recommendation. Dr. Porter presented the following motion:[16]

> The Space Science Board recommends to the Government (NSF, ARPA, NASA, and Science Advisor's Office) that immediate support be given as necessary to the following experiments for development at the optimum rate:
>
> 1. A Light-Pumping Magnetometer
> 2. Atomic Clock Experiment
> 3. Self-Illuminated Satellite
> 4. Inflatable Sphere (100')
> 5. Bolometer
> 6. Study of Auroral Particles (added by amendment)

The end result was that these projects were communicated to the Government on July 24, 1958,[17] thereby establishing a precedent for the advisory role to be played by the Space Science Board. Recommendations concerning these deliberations were forwarded to the National Aeronautics

---

[15]Memorandum from Dr. Hugh Odishaw, Executive Director, Space Science Board, Washington, D. C., July 24, 1958. See Appendix D for the transmitting letter from Dr. Porter accompanying this report.

[16]Minutes of the Second Meeting, Space Science Board, p. 11

[17]Space Science Board, Report of Activities, June 1958 - June 1959, Washington, D. C., p. 3.

and Space Administration and the National Science Foundation in the fall of 1958 and early 1959. Thus, the Board assisted NASA, immediately upon its formation, in establishing its initial program of scientific research in space. A further result was an orderly transition of work conducted under the Academy's IGY Satellite Panel to be carried on by the new space agency.[18]

---

[18]Report to Congress from the President of the United States, U.S. Aeronautics and Space Activities, January 1 to December 31, 1959, pp. 51-52.

CHAPTER IV - BOARD ORGANIZATION

The first meeting, on June 27, 1958, also established the precedent for the formal structure of the Space Science Board. The members agreed to apportion their work among themselves on a temporary basis, in order to permit modifications as determined by experience and necessity. Thus, the following twelve ad hoc committees were agreed upon at this meeting:[1]

Committee 1--Chemistry of Space and Exploration of Moon and Planets

Committee 2--Optical and Radio Astronomy

Committee 3--Future Vehicular Development

Committee 4--International Relations

Committee 5--Immediate Problems

Committee 6--Space Projects

Committee 7--The Ionospheres of the Earth and Planets

Committee 8--Physics of Fields and Particles in Space

Committee 9--General Engineering Service and Coordination

Committee 10--Meteorological Aspects of Satellites

Committee 11--Psychological and Biological Research

Committee 12--Geodesy

The chairmen of these committees--that is, the members of the Board--were requested to select their respective committee members with the approval of Dr. Lloyd V. Berkner, Chairman of the Space Science Board,

---

[1]Space Science Board, Report of Activities, June 1958 - June 1959, Washington, D. C., p. 2.

and Dr. Detlev Bronk, President of the National Academy of Sciences. Dr. Berkner also urged the committee chairmen to keep their committees small. Plans also were inaugurated for a Secretariat, which would aid the committees and would consist of "a minimum of 6-7 professional staff members with adequate secretarial assistance."[2]

The committees themselves were organized along the lines of various scientific disciplines and activities affiliated with the nation's scientific space research program. The functions of the committees, in general, were outlined by Chairman Berkner at this first meeting:[3]

> (1) In general, as designated in the Space Board charter provided by President Bronk. More specifically, for each committee within its field to investigate all aspects of problems such as payload compositions, relative importance of experiments, trajectory, timing, environmental effects, orbital requirements, and so forth, in relation to the effort and cost involved.
>
> (2) To develop knowledge through symposia, publications, committee membership and so forth.
>
> (3) To make reports to the Space Science Board. In turn, based on the work of the committees, the Space Science Board must issue studies of:
>
> a. Scientific programs and timing
> b. Vehicle requirements and timing
> c. Extent and character of support
> d. Long-range national plan.

Many of the committees of the Space Science Board have changed not only their titles and functions but also their number and membership, as

---

[2]Minutes of the First Meeting, June 27, 1958, Space Science Board, p. 11.

[3]Ibid., pp. 10-11.

the country's space program has evolved. In fact, through the years the number of committees has grown to as many as fifteen while total membership has surpassed 150.[4]

Among the members of each of the Board's committees are liaison representatives from various Government agencies. Although the majority of the Board's work concerns NASA, participants from other organizations such as NSF and DOD have been on SSB committees at one time or another. Their presence has been vital in order to acquaint committee members with the plans and activities of agencies such as NASA. Yet, it is most important to note that these liaison representatives were not expected to engage in committee discussions involving recommendations to be made to their respective agencies; they were to serve the purpose of keeping the committee members informed of current plans and programs.[5]

More specifically, the work of the Board's committees was not to be influenced toward any agencies represented on these committees:[6]

> The participation of these representatives in future meetings of the SSB committees should be most profitable in informing committee members of agency activities and plans. It is not expected that NASA and NSF liaison representatives will participate in the development of committee conclusions and recommendations: these agencies consider that SSB recommendations of this type should be developed independently and objectively by our committees.

---

[4]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1961, Washington, D. C., p. 67.

[5]Memorandum from Richard Peavey, Secretary, Space Science Board, "NASA Liaison Appointees to SSB Committees," October 9, 1959.

[6]Memorandum from Hugh Odishaw, Executive Director, Space Science Board, "Liaison Representatives," October 29, 1959.

Direct interaction between the committees of the Space Science Board and various Government agencies also occurs when a specific work request made of the Board is forwarded directly to one of its committees. For instance, in January 1960 the National Aeronautics and Space Administration requested Board advice on "immediate and long-range planetary and interplanetary explorations program."[7] The Board responded not only by requesting its committees to study the problem but also by planning a three-day meeting to "review the studies of the Committees in order that it [the SSB] can organize its effort in this regard more completely."[8]

In addition to its regular ad hoc committees, the Space Science Board also convenes special study groups to consider specific problems affecting space research. Studies have been made in such important areas as recommendations for radio frequency allocations for space research (in conjunction with the International Telecommunications Union), and the consequences and prevention of contamination by space probes impacting upon extra-terrestrial bodies (again an international area involving the United Nations).[9]

Just as specific work requests from various agencies are forwarded to Board committees, special study groups may be formed to consider a

---

[7]Letter from Hugh Dryden, Deputy Administrator, National Aeronautics and Space Administration, January 13, 1960.

[8]Letter from Lloyd Berkner, Chairman, Space Science Board, January 26, 1960.

[9]Report to the Congress from the President of the United States, U.S. Aeronautics and Space Activities, January 1 to December 31, 1959, Washington, D. C., p. 53.

particular problem. For instance, the Space Science Board established an ad hoc study group to assess, in terms of scientific needs, the NASA facilities for the tracking of satellites and the determination of their orbits. The result was that NASA, which had originally requested such a study, received a conclusive report summarizing its program.[10]

These special study groups present a convenient means by which the Board can fulfill its advisory role. Often a relatively small or highly specialized study can be dealt with by an ad hoc working group. This technique also functions quite well in the opposite direction; a study group can also be extended in several ways. For instance, in 1964 the Board formed an Exobiology Study Group upon request from NASA to "develop the aims of and the proper strategy and approach to the search for extraterrestrial life."[11] This study was eventually completed in 1964 and a report was published in April 1965. The Exobiology Study Group was then reconvened in October 1965 to "consider the results of photographs of Mars and of other scientific data obtained from the Mariner IV mission, and other recent data on Mars."[12]

Another integral part of the structure of the Space Science Board is its Executive Committee. This body was formed as the result of the

---

[10] United States Aeronautics and Space Activities, 1961, p. 69.

[11] Ibid., 1964, p. 96.

[12] Ibid., 1965, pp. 99-100.

reorganization of the Board during 1961 and 1962. Whereas the entire Space Science Board usually meets twice annually, the Executive Committee convenes approximately four times a year.[13] In this way, the Committee is able to accomplish a great deal of work on the part of the SSB without the inconvenience of a full meeting of the Board.

The Board's reorientation was a direct result of the reorganization of NASA and the desire to improve NASA-SSB relations. These subjects were raised in a letter, dated October 25, 1961, from Dr. Hugh Dryden, Deputy Administrator of NASA, following a meeting attended by SSB representatives Dr. Berkner and Dr. Odishaw and by James E. Webb, Administrator of NASA, and Dr. Dryden. This letter instituted a discussion of some critical working arrangements between the Board and the space agency, at a meeting of the former body on November 12 and 13, 1961. A number of important decisions were reached concerning the reorganization of the Board, among which was "an agreement to establish a small Executive Committee which would meet much more frequently than is possible for the full Board."[14]

It was expected that the Executive Committee would examine fairly broad issues involving present programs and future plans for scientific research in space. Furthermore, it was anticipated that this body would perform an important function as liaison between the National Aeronautics and Space Administration and the Space Science Board at a high management

---

[13] Interview with Hugh Odishaw, Executive Director, Space Science Board, August 2, 1966.

[14] Letter from Lloyd Berkner, December 1, 1961.

level. In effect, the Executive Committee was to conduct Board business when the full committee was not needed or could not be readily convoked to serve as a mechanism for planning the Board's work in major areas, and to be more available as a consultative body to the senior officials of NASA.[15]

This arrangement also would make consultative advice more available for other interested Government agencies as well. Furthermore, it was satisfactory to the Space Science Board:[16]

> Because the full Board itself cannot meet often, it seems that a smaller group would be useful as an advisory body on space problems, vehicles, sequences, etc. To be effective this group should meet two days each quarter. Appropriate communications to the Board by the staff would permit this group to have Board consensus as the basis for its work. Aside from its value to the Board and staff, Mr. Webb has indicated interest in such a group.

It also satisfied the National Aeronautics and Space Administration: "...both Mr. Webb and Dr. Dryden feel the need for frequent consultation and are most anxious that such a body be established without delay."[17]

The first meeting of the Executive Committee was held on February 12, 1962, with five members in attendance--along with the Secretariat and a number of participants from NASA. No formal agenda was prepared for this meeting; it was mainly concerned with establishing the groundwork and

---

[15] Ibid.

[16] Memorandum from Lloyd Berkner, November 3, 1961, p. 3.

[17] Letter from Lloyd Berkner, January 5, 1962, p. 2.

developing topics for future consideration by the Committee.[18] Subsequent meetings have demonstrated the usefulness of the Executive Committee not only in its carrying out the advisory role of the Board but also in its fulfilling the valuable function of providing a means by which NASA can brief the Board on the nation's space program.

The period of reorganization of the Board also involved the installation of a new chairman. Dr. Lloyd Berkner, who had been Chairman of the Space Science Board since its establishment in 1958 (in which Dr. Berkner played an instrumental role), remained a member of the Board. Dr. Berkner was replaced, during the reorientation of the Board, at his own request but continued to play a crucial role in advising on the national space program, particularly regarding scientific research. To fill this important position, the National Academy of Sciences, under the presidency of Dr. Frederick Seitz, selected Dr. Harry Hess, who at present continues to serve as Chairman of the Space Science Board.[19]

---

[18]Minutes of the First Meeting, February 12, 1962, Executive Committee, Space Science Board, Washington, D. C.

[19]Letter from Lloyd Berkner, January 5, 1962, p. 2; letter from Lloyd Berkner, July 16, 1962.

CHAPTER V - BOARD MEETINGS

To accomplish its work, the Space Science Board as well as the Executive Committee, various standing committees, and study groups all hold meetings at fairly regular intervals dependent upon the specific tasks of each group. As has been pointed out, the Executive Committee meets about twice as often as the Board itself due to the difficulty of gathering together all the SSB members, who, because of their important positions outside the Board, are inevitably not always available. The more basic work of the Board is conducted by committees and study groups which comprise the main body of the SSB but meet more often.

Although the first meeting of the Space Science Board was devoted to discussions of the functions of the Board and its organization, subsequent meetings have been primarily concerned with reviewing committee work for presentation as well as future assignment. The second meeting is thus contrasted with the first by its emphasis on the actual experimental program to be recommended for scientific research in space, whereas the first meeting may be depicted by the following quote from the minutes of that meeting:[1]

> In summary Chairman Berkner summarized the Tasks of the Board thus:
>
> 1. To collect information.
> 2. To broaden the base of Space Science.
> 3. To develop a national Space Science program that is effective scientifically.

---

[1] Minutes of the First Meeting, June 27, 1958, Space Science Board, p. 14.

The second meeting consequently set the trend to be followed by succeeding meetings. At this meeting, held less than one month after the first, the Board endorsed six satellite experiments for earliest employment. The Board also devoted some discussion, at this second meeting, to the development of a short-range program of scientific space research. This program was then forwarded to the appropriate committees for further study and evaluation, thereby originating this method of assigning work to the body of the Space Science Board.[2]

The third meeting of the Board, and the last to be held in 1958, was occupied for the most part with committee reports, by the members of the Board in their roles as committee chairmen, on the recommendations of the short-range program. Nine of the Board's committees were able to submit accounts of meetings which they had been able to hold since the Board's inception only four months before.[3]

Other important action taken by the Board at this meeting included an agreement to furnish NASA, NSF, ARPA, and the President's Science Advisory Committee (PSAC) with the recommendations of the Board. Another noteworthy event was a recapitulation of the obligations of the Space Science Board:[4]

> With regard to the general responsibility and modus operandi of the Board, Dr. Berkner stated that the first responsibility was to formulate and publish the short-range program for space science and secondly, to generate the interest of the scientific community in participating in the space science program.

---

[2]Lloyd Berkner and Hugh Odishaw (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 82.

[3]Minutes of the Third Meeting, October 24, 1958, Space Science Board.

[4]Ibid., p. 7.

> It was noted that the Board does not plan to become operational but would continue to be advisory to operational agencies.

The Board meetings, which were held in New York City during 1958, were further augmented that year by a number of inspection trips. The Board surveyed the Army Ballistic Missile Agency at Huntsville, Alabama; the Air Force Ballistic Missile Division and Space Technology Laboratories; the Douglas Aircraft Corporation; the Rocketdyne Division of North American Aviation; and the Atlantic Missile Range at Patrick Air Force Base, Florida. The purpose of these visits was "to gain an orientation on space vehicular programs underway, development and launching facilities available to scientists, an understanding of the hardware involved, and the complexities of the systems in use..."[5]

This practice was extended the following year to include the actual meetings of the Board. During 1959 the three major meetings of the Board were held at the Atlantic Missile Range, Cape Canaveral, Florida; at NASA Headquarters and the Advanced Research Projects Agency, Washington, D. C.; and at the Missile and Space Vehicle Department of the General Electric Company, Philadelphia, Pennsylvania. Senior officials of NASA, NSF, and agencies of the Department of Defense offered reviews of current as well as future programs involving scientific research in space. This policy, in general, helped provide valuable liaison between the Board and the interested federal agencies. Specifically, its purpose was "to ascertain the state of the research being conducted, to single out major problems requiring solution, and to devise the best possible means of

---

[5]Berkner and Odishaw, p. 82.

drawing broadly upon the talents of scientists throughout the nation in the conduct of the space research program."[6]

The fourth meeting of the Space Science Board, held January 17-20, was comprised of detailed briefings as mentioned above as well as some committee reports.[7] Another noteworthy aspect of these meetings occurred during the fifth one, held May 7-9, at which time the Board's tasks were redefined by Dr. Berkner:[8]

> The Chairman suggested that, in his opinion, the briefings by the three agencies with space programs (NASA, ARPA, and NSF) make it abundantly clear that they are now well [enough] organized to conduct efficient programs; that, therefore, the SSB should discontinue its detailed review of specific proposals, and should confine itself to interests falling broadly in the following categories:
>
> (a) Long range planning;
> (b) Surveying for 'gaps in knowledge' -- i.e., areas important for an effective space program, the investigation of which can be carried out on the ground, but which have been neglected so far; and the encouragement of research in these areas;
> (c) Stimulating universities and other non-government research institutions to take an interest in space science; informing them of opportunities in this field; and promoting a harmonious relationship between them, on the one hand, and the agencies and their payload contractors on the other;
> (d) Continued activity in the field of international cooperation, particularly through ICSU-COSPAR.

The sixth meeting, on October 23-24, followed the general format of the other two meetings held in 1959. On behalf of Dr. Dryden, Dr. Homer E.

---

[6]Report to Congress from the President of the United States, U.S. Aeronautics and Space Activities, January 1 to December 31, 1959, p. 52.

[7]Minutes of the Fourth Meeting, January 17-20, 1959, Space Science Board.

[8]Minutes of the Fifth Meeting, May 7-9, 1959, Space Science Board, p. 5.

Newell presented a summary of the NASA space science program.[9] This action established another precedent for the Space Science Board; it eventually led to a formal presentation, annually, of a report of the activities of Dr Newell's office, which is presently known as the Office of Space Science and Applications.

During 1960 the Board devoted its primary attention to the longer-range objectives of space research, in contrast to its earlier activity of reviewing proposals for the neophyte space research program. The specialized committees and study groups of the Board held over twenty meetings in 1960 "to consider development of comprehensive program goals for planetary exploration in the 1970's, followed by a similar study of the research programs for the 1960 decade to ascertain what would be required to insure the success of the later planetary program."[10]

This investigation of the long-range goals of the national program of scientific research in space arose as a result of discussions, conducted at the sixth meeting of the Space Science Board, forwarded to PSAC and NASA. The President's Science Advisory Committee subsequently reactivated its own Space Science Panel to re-evaluate the nation's space program while requesting Board advice in this area. At the same time, the National Aeronautics and Space Administration sought similar assistance from the Board.[11]

---

[9]Minutes of the Sixth Meeting, October 23-24, 1959, Space Science Board.

[10]U.S. Aeronautics and Space Activities, January 1 to December 31, 1960, p. 58.

[11]Minutes of the Seventh Meeting, March 10-11, 1960, Space Science Board, pp. 1-2.

This request from NASA was communicated to the Board between its sixth and seventh meetings. On January 13, 1960, the Deputy Administrator of NASA wrote to the Chairman of the Space Science Board, Lloyd Berkner, to ask for the Board's views on both the immediate and long-range space exploration program:[12]

> The NASA is beginning serious preparation of scientific payloads for investigation of the planets and interplanetary space at multi-million mile distances from the earth. The NASA Office of Space Sciences is presently working out the initial planning for the more immediate and long-range planetary and interplanetary exploration program. It would be of great value to NASA to have from the Space Science Board the thinking of the Board's members on this subject. Of especial value would be a review of the major scientific problems that ought to be attacked with some indications of the order, from a scientific point of view, in which the exploration should proceed.

The basis for this assistance is evidenced in discussions of the renewal of the SSB contract for Fiscal Year 1960. Specifically, attention is called to the work request, transmitted on October 20, 1959, to the Board from NASA:[13]

> The National Aeronautics and Space Administration would like to have from the Space Science Board a continuing input of thoughts, ideas, and recommendations on the broad overall objectives, and the course that the space science activities in the United States should take. ...NASA would find such an input from the different committees of great value in the detailed formulation of

---

[12]Letter from Hugh Dryden, Deputy Administrator, National Aeronautics and Space Administration, January 13, 1960.

[13]Work Request to the Space Science Board, October 12, 1959, pp. 1-3. This somewhat-redundant work request may be found in Appendix E.

> the NASA national space sciences program. In this connection, it may be of value, from time to time, to call upon individual Space Science Board committees to meet at NASA for a working session to consider with the NASA space science staff specific problems of program planning.

As a result of these requests from PSAC and NASA, a memorandum was sent to the entire Space Science Board--that is, to the committee chairmen and members. It outlined the tasks which had been submitted to the Board and solicited the appropriate response from the committees. This memorandum, which is attached in its entirety as Appendix F, signified an important change in the Space Science Board:[14]

> What should be the nature and scope of the U.S. space program over the coming years? The present task of the Board is to answer this question. The government has requested SSB assistance in this area.
>
> While the Board has made major contributions to the national space effort through its recommendations in the past, these recommendations have been to some extent ad hoc and short range...
>
> The Board has a unique opportunity to affect policy and budgets at this time.

The seventh meeting of the Space Science Board was held March 10-11, 1960, with the knowledge of the Board's new work assignment. Although there had not been enough time to prepare before this meeting to devote the meeting entirely to these new tasks, some steps were taken in this direction. As a result of this meeting reports containing Board recommendations were forwarded to NASA not only on the present program of the

---

[14]Memorandum from Hugh Odishaw, Executive Director, Space Science Board, February 5, 1960, p. 1.

space agency but also on some of the future program objectives:[15]

> Basically, the reports provide Board recommendations on two phases of the space sciences program: (1) those relating to the present NASA program, and (2) those relating to program objectives several years in the future, with major emphasis given to the objectives for lunar, planetary, and interplanetary research programs. Although the Board has not completed its current study of program objectives falling into category (2), the present recommendations should be construed as an interim response to Dr. Dryden's letter of January 13, 1960, which requested Board advice in this area and to the NASA Work Request to the Board transmitted on October 20, 1959. We expect that further recommendations concerning the objectives of the planetary and interplanetary space science programs will be available following the next meeting of the Board on June 26 and 27.

The eighth meeting of the Board, from June 24 to June 27, was the last meeting to be held in 1960. Although only a three-month gap existed between this and the previous meeting, there was a considerable increase in the amount of data presented concerning the long-range objectives of the nation's space program.[16]

The actual inauguration of these new tasks must be assigned to the Board's activities during 1961. Although the Space Science Board had begun to devote itself primarily to the long-range objectives of space exploration and the accompanying program of scientific research the previous year, the Board actually began to adjust to this new assignment in 1961. By this time the Board had completed its

---

[15]Letter from Hugh Odishaw, Executive Director, Space Science Board, May 23, 1960.

[16]Minutes of the Eighth Meeting, June 24-27, 1960, Space Science Board.

initial objectives of advising on the selection of specific scientific projects for space research. Hence, only a small number of the regular SSB committees was convened. However, about thirty meetings of ad hoc study groups, as well as informal discussions, were held to consider recommendations for the 1960 decade.[17]

The Board itself held two meetings in 1961, the most productive one[18] convening in Washington on February 10 and 11, and a later one, also in Washington, in November. NASA personnel were present to give detailed briefings at these two meetings to supplement the prepared program papers which were becoming standard material to make available beforehand. The primary functions of these particular Board meetings were "to (i) receive reports of its special study groups, (ii) formulate its [the Board's] advice and guidance for those executive agencies concerned with the civilian space science program, and (iii) develop its international relations program activities."[19]

The evolution of the Space Science Board, in the light of its adoption of new goals, continued in 1962 and 1963. In fact, this period witnessed the reorganization of the Board, as already has been pointed out--no doubt also a consequence of the reassignment of primary tasks to the Board. In 1961, the SSB found itself relying less on its standing

---

[17] United States Aeronautics and Space Activities, 1961, p. 67.

[18] The results of the ninth meeting of the Space Science Board are related in the following chapter.

[19] Space Science Board, Report of Activities, January-December, 1961, p. 2.

committees and organizing more ad hoc groups. The result, in the next two years, was a reorientation of the Board toward "a minimum number of standing committees, augmented as necessary by small, highly specialized ad hoc groups."[20]

The Board itself held its eleventh meeting on October 18, 1962, in New York City at the American Institute of Physics. This meeting was primarily concerned with the effect on the tasks of the Board of the Space Science Summer Study held in 1962.[21] The twelfth meeting of the Space Science Board, held on the 13th and 14th of May, 1963, served as a means by which to acquaint the Board members with recent activities of Government agencies.[22]

The final meeting of 1963, as well as the first one in 1964, differed from the above two in that they were quite evenly balanced. These thirteenth and fourteenth meetings apparently devoted equal attention to (1) Space Science Board activities, including a general review as well as future plans; (2) international activities, in relation to COSPAR; and (3) activities of Government agencies, featuring reports by representatives not only from NASA but also NSF and DOD.[23]

---

[20]Space Science Board, Report of Activities, 1962-63, pp. 5-6.

[21]Minutes of the Eleventh Meeting, October 18, 1962, Space Science Board.

[22]Minutes of the Twelfth Meeting, May 13-14, 1963, Space Science Board.

[23]Minutes of the Thirteenth Meeting, December 6-7, 1963, Space Science Board; Minutes of the Fourteenth Meeting, May 27, 1964, Space Science Board.

The fifteenth meeting of the Space Science Board is known as a Special Meeting. The pattern of the previous two meetings was disrupted to allow for a luncheon session with NASA Administrator James Webb, as well as other senior NASA officials. Mr. Webb "provided the Board with his assessment of NASA's accomplishments, the problems facing it, and his views on its future objectives."[24]

The seventeenth meeting, held in November of 1965, was also different, in that it entailed a general review of the Summer Study held in 1965 at Woods Hole, Massachusetts. The Board then turned its attention, at this meeting, to a review of SSB tasks based upon the Woods Hole Study. Specifically, it concerned itself with (1) the problem of balance and priorities, within the total national space program as well as its scientific aspects; (2) the question of the Board's support of the national space effort; and (3) relations with other Government agencies.[25]

---

[24]Minutes of the Fifteenth Meeting, September 11-12, 1964, Space Science Board.

[25]Minutes of the Seventeenth Meeting, November 12-13, 1965, Space Science Board.

CHAPTER VI - BOARD REPORTS [1]

The Space Science Board, as part of its advisory role, has submitted a number of major reports on scientific research in space both to Government agencies in general and to the U.S., as well as to the international, scientific communities. The international aspects of the Space Science Board will be covered in a later chapter; the domestic role of the Board--especially regarding NASA--is the primary concern of the next few chapters.

The first major report appeared in print as Science in Space (McGraw-Hill, 1961). This volume was edited by the Chairman and Executive Director of the Space Science Board--respectively, Lloyd Berkner and Hugh Odishaw. This book furnished, when it was published, a review of opportunities and problems in space research, of interest not only to scientists but also to readers in general concerned with the national space effort. Most significantly, it pointed out the importance of scientific research in space:[2]

> The spectacular growth of space activity since the launching of Sputnik I on October 4, 1957, requires careful assessment of the opportunities that space exploration provides so that emphasis on those opportunities is reasonably optimized. Among the space activities of exploration, application, and scientific research, the last is precedent to man's other space endeavors. Space applications and man-in-space ventures depend for their success on adequate

---

[1] This chapter is based upon a speech, entitled "The Academy and Space Research," prepared by the President of the National Academy of Sciences, Frederick Seitz, for presentation on December 15, 1964.

[2] Lloyd Berkner and Hugh Odishaw (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 2.

> knowledge of space. Consequently, the necessary antecedent research must be completed before dependent space activities can be most effectively pursued. In addition, space offers a whole new vista of scientific advancement which before was inaccessible. Scientific experiments in many exciting fields of knowledge can now be planned, and these can supplement older methods of research in a very critical way.

In December of the same year, the Board published a study on planetary atmospheres entitled Atmospheres of Mars and Venus. This five-chapter report was a summary of what was known about such planetary atmospheres as well as a presentation of various interpretations. This work was the result of a combined symposium and working session convened by the Board in June 1960 and a special study group which actually prepared the report. It recommended for investigation the most important aspects, unknown at the time, concerning planetary atmospheres. This study served "as an authoritative compilation of current knowledge of planetary atmospheres and as a reference work for designing planetary missions."[3]

The third major work of the Space Science Board was actually a set of two reports issued as a result of the ninth meeting of the Board held on February 10 and 11, 1961. These were two policy statements entitled Man's Role in the National Space Program and Support of Basic Research for Space Science. Although both were published in March of 1961, the

---

[3]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1961, pp. 69-70.

former was not released publicly until August of that year.[4]

The first of these policy statements was the direct result of the Board's February meeting. It attempted to evaluate the major objectives of space exploration. Man's Role in the National Space Program recommended:[5]

> ...scientific exploration of the Moon and planets should be clearly stated as the ultimate objective of the U.S. space program for the foreseeable future. This objective should be promptly adopted as the official goal of the United States space program and clearly announced, discussed, and supported.

The other policy statement was initially concerned with the patronage of basic research in space. Support of Basic Research for Space Science emphasized that a larger effort was necessary if the long-range national space program was to be successful:[6]

> NASA has an extensive and growing space flight program directed to fundamental problems of space research. However, the space flight program is only a part of the total space research effort that the country should undertake for several reasons: to make full use of the potentials of the scientific community, to capitalize upon the interplay that comes from a variety of approaches, to acquire as much advance knowledge as possible prior to spacecraft missions, and to acquire fundamental knowledge by the most economical technique.

---

[4]Report of the National Aeronautics and Space Administration, Aeronautical and Astronautical Events of 1961, Washington, 1962, p. 6, p. 13, and p. 38.

[5]U. S. Congress, Senate, Committee on Aeronautical and Space Sciences, National Goals for the Post-Apollo Period, 89th Cong., 1st Sess., 1965, p. 242. Cited hereafter as National Goals. The official text is located in Appendix G.

[6]Report of the Space Science Board, Support of Basic Research for Space Science, March 27, 1961.

> ...The Space Science Board believes that an extensive scientific program is called for immediately -- one oriented not toward specific payloads but directed toward the adaptation of old and the devising of new experimental concepts and techniques appropriate to the work to be done in space. Looking ahead, the problem is how to acquire the most significant experiments. This can only come about by the continuous research efforts of the community of scientists throughout the nation.

The first of this set of policy statements attracted the most attention and brought the Space Science Board into the public view. Man's Role in the National Space Program supported President Kennedy's May 25 statement making a manned landing on the Moon before 1970 a national objective of the space program. The Washington Post reported on Monday, August 7, that this report had "a profound influence on members of the President's Science Advisory Committee, many of whom were known to be reluctant about the President's decision to commit the nation to a multi-million dollar effort to be first in space."

This document does, in fact, serve as an example of the fulfillment of the advisory role of the Board. The Space Science Board was acting on behalf of the U. S. scientific community when it endorsed the scientific exploration of space. Criticism has been leveled at the Board regarding such statements as the ones contained in this report. Yet the fact remains that the SSB is the only authoritative, independent, organized body of scientists capable of passing judgment on such policy questions.

Another point to bear in mind is that just as no group, even of this caliber, can be entirely objective, nor can those who review the conclusions of such groups. The case in point reveals this quite distinctly;

witness the two different headlines appearing in The Washington Post and The New York Times respectively on August 7, 1961: "Scientists Endorse Exploration of Space" versus "Scientists Warn of Trips to Moon."

One major report of the Space Science Board arose as a result of the growing national space program and the need for a review of the program recommendations made in March 1961. National Goals in Space, 1971-1985, released on November 17, 1964, was based on an earlier memorandum from the Space Science Board to Dr. Homer Newell. This memorandum, entitled "Future Goals of the Space Science Program," was forwarded to NASA in August of 1964. It represented "the consensus of the Space Science Board on a primary goal and a NASA program following Apollo, the manned lunar landing, and results from a review of NASA programs and earlier Board positions and was stimulated by a NASA invitation for the Board's views on its response to President Johnson's request."[7]

This revision of the goals of planetary exploration was the subject of further discussion at informal meetings between NASA officials and SSB members as well as the fifteenth meeting of the Board held in September 1964. National Goals in Space, 1971-1985 was transmitted to NASA in October 1964 as a result of the above proceedings, and in response to a request from NASA to the Chairman of the Space Science Board, Harry Hess, for the Board's opinion of the long-range NASA goals.[8]

---

[7]Memorandum from Harry Hess, Chairman, Space Science Board, August 11, 1964.

[8]Letter from Frederick Seitz, President, National Academy of Sciences, October 30, 1964.

This document recommended that the primary objective of the national space effort in the 10-15 years following the Project Apollo manned lunar landing be unmanned exploration of the planet Mars. This program for the 1971-85 period would ensure the greatest scientific return, while utilizing the equipment developed for Apollo. These recommendations of the Space Science Board for the post-Apollo period were arrived at by considering:[9]

> ...what programs would produce the most significant advances in understanding during the next decade, how the nation could most intelligently build on Apollo achievements while still preparing to accept unforeseen delays, and how an uninterrupted flow of scientific results, consistent with the size of the national investment in space exploration, could best be assured over the next 20 years.

This statement by the Board, National Goals in Space, 1971-1985, appears as Appendix G. The following points were emphasized as the unanimous views of the Board:[10]

1. The Mars program should be the major goal past 1970, starting unmanned with the Saturn class of vehicles with suitable decontaminations.
2. The lunar program should be continued but subordinated to the Mars effort, recognizing continued lunar scientific goals.

---

[9]Public Statement of National Academy of Sciences, November 17, 1964.

[10]National Goals, p. 243.

3. A continued program of science in space is essential with respect to

   (a) Earth itself;
   (b) Interplanetary space;
   (c) Solar physics and preliminary exploration of other space objects;
   (d) Astronomical observations outside the atmosphere.

   This program is essential to the accumulation of basic information for manned programs. The development of standardized vehicles could reduce its cost.

4. The manned Earth orbital program should be developed for rescue, service of unmanned vehicles, and several military objectives such as inspection, but should be a secondary - not a primary - goal.

5. Flexibility should be provided in all these programs to permit exploitation of any major, unforeseen breakthrough or discovery. The Board agrees that our space program must satisfy all national objectives, but that to do this the scientific program must make a maximum of sense.

6. Obvious applications should be exploited quickly, as now planned.

The recommendations suggested by National Goals in Space, 1971-1985 were also the subject of testimony before the Senate Committee on Aeronautical and Space Sciences in August 1965. Although the Space Science Board had furnished Congressional testimony before, these hearings were primarily concerned with the post-Apollo goals of the U.S. space effort so that SSB participation was of particular importance. Three members of the Board--Dr. Lloyd Berkner, Dr. Harry Hess, and Dr. Gordon MacDonald--appeared before the Senate Committee. They reiterated the recommendation of National Goals in Space, 1971-1985 that unmanned exploration of the planets, particularly Mars, be emphasized.[11]

---

[11] Ibid., pp. 227-299.

The Space Science Board submits, of course, many other reports to Government agencies by way of performing its advisory role. An example of this type of work can be found in the relations of the Board with the President's Science Advisory Committee. In October of 1959, Dr. George Kistiakowsky, the Chairman of PSAC, invited Dr. Detlev Bronk, the President of NAS, as well as some SSB representatives, to present to the Committee "the Board's observations on the present and planned U. S. program in space science."[12]

As a result of this request, Dr. Lloyd Berkner appeared before PSAC at its next meeting on November 9, 1959. The Chairman of the Space Science Board discussed the Board's position on the state of the U. S. program of scientific research in spaee. He stressed the fact that the Board believes there are three separate and distinct basic objectives of the space effort: (i) Exploration-achievement of a sound national program in space exploration; (2) Science-conduct of a sound scientific program; and (3) Applications-exploitation of space opportunities for the benefit of mankind.[13]

---

[12]Letter from George Kistiakowsky, Chairman, President's Science Advisory Committee, October 22, 1959.

[13]Statement of Lloyd Berkner, Chairman, Space Science Board, November 9, 1959.

CHAPTER VII - SUMMER STUDIES

Another function of the Space Science Board--one related to the Board's policy of furnishing reports on scientific research in space--is the support of Space Science Summer Studies. The concept of a summer study evolved from discussions at the tenth meeting of the SSB: as a consequence, two studies have been conducted to date. The analysis and conclusions of the first study held at the University of Iowa in 1962 were published as A Review of Space Research. The results of the second one, convened in 1965 at Woods Hole, Massachusetts, were released as Space Research: Directions for the Future.

In the fall of 1961, discussions arose between the National Aeronaitcs and Space Administration and the Space Science Board concerning the necessity for an evaluation of the status of scientific research in space conducted by the U. S. Thus, plans were inaugurated to convene a summer study, under the direction of Dr. James Van Allen, the following year, to explore the future objectives of the national space effort. This project was given, in the fall of 1961, full support by Mr. Webb, Dr. Dryden, and Dr. Newell on behalf of NASA.[1]

The Secretariat of the Board, in conjunction with Dr. Van Allen and his staff, as well as representatives of NASA, undertook the summer study planning, which was periodically reviewed by the SSB Executive Committee. A broad outline, initially developed for the program, was subsequently provided with guidelines for the investigation of the

---

[1] Letter from Lloyd Berkner, Chairman, Space Science Board, December 1, 1961.

objectives of basic research in space rather than a review of the entire NASA program. The subject ultimately covered consisted not only of a review of previous experiments but also of a consideration of new topics. Even more earthly topics as NASA's relationship with the academic community were investigated.[2]

Arrangements to include scientists from a wide variety of disciplines relative to the NASA program resulted in the participation of a full-time group of twenty-one scientists and ninety-two others on a part-time basis. Similarly, plans to include key NASA scientific and administrative personnel in the program accrued eighty-nine such representatives. Other participants from such Government agencies as the Department of Defense, the Atomic Energy Commission, the National Science Foundation, and the National Bureau of Standards also contributed to the eight-week study.[3]

It should be noted again, as in previous SSB conferences involving representatives from agencies such as NASA which wish to employe the advice of the Board, that the participation of such personnel by no means warrants the accusation of undue influence towards the agencies concerned. After all, these deliberations could not possibly be as well-informed without the active participation of those individuals who are best acquainted with the programs under discussion. Yet--and here is where the value of the Space Science Board lies--a conscious effort

---

[2] Report of the 1962 Summer Study: A Review of Space Research, Space Science Board, Washington, D. C., 1962, p. 1-1 and p. 1-4.

[3] Ibid., p. 1-30.

is constantly made, on the part of the Board, to ensure that reports, such as the one evolved from the 1962 Summer Study, are as objective as possible:[4]

> These [NASA] representatives participated fully in the discussions to inform participants concerning the details of NASA's current programs and plans in each scientific field and to describe the policies and procedures employed in the conduct of the operating program. NASA representatives did not, however, join in development of the Study conclusions and documents...

The Iowa Study commenced with a number of briefing sessions on the existing programs and policies of scientific space research. The programs in each scientific area were then examined in detail for two weeks in smaller meetings. Preliminary reports of these groups were then submitted while the remainder of the Summer Study was planned. Consideration was then afforded, in the remaining weeks, to administrative and policy matters. Reports were again offered in these subjects, while plans were formulated for the concluding reports. Finally, the results of the 1962 Summer Study were presented, verbally to top officials of the National Aeronautics and Space Administration and of other agencies.[5]

Early in 1963 the formal report of this Study, held from the middle of June to the middle of August the previous year, was transmitted to the Government and made available to the public. A Review of Space Research, which constituted sixteen chapters, represented the consensus of more than one hundred scientists. This document, which endorsed the NASA

---

[4] Ibid., p. I-30 (underline by the author).

[5] Ibid., p. I-31.

program of scientific research in space, strongly recommended the quest for life beyond the earth as part of the U. S. space effort:[6]

> Of all the discoveries that have come from or can now be anticipated from man's efforts in space science, none more easily captures the imagination nor is more likely to focus interest and acclaim than the empirical proof that there is in the universe a biota other than our own. On solid scientific grounds, on the basis of popular appeal, and in the interests of our prestige as a peace-loving nation capable of great scientific enterprise ...finding and exploring extraterrestrial life should be acclaimed as the top priority scientific goal of our space program.

A Review of Space Research also recommended that NASA consider the construction of a number of new satellites and institute plans for the manned exploration of Mars, besides assigning the investigation of extraterrestrial life as a prime national goal. Attention was also drawn to the subject of scientist-astronauts. In fact, the report expressed the desire of the scientific community for a more substantial role in the manned space flight program.[7]

The 1962 Space Science Summer Study eventuated not only the 16-chapter survey A Review of Space Research but also an increased appreciation of the national space effort on the part of the scientific community. In addition, NASA personnel had an opportunity to exchange thoughts with specialists from universities and industry. On the whole,

---

[6]Public Statement from the National Academy of Sciences, Washington, D. C., January 6, 1963.

[7]Heather David, "Three-pronged Role Urged for NASA," Missiles and Rockets, January 14, 1963, p. 19.

the Iowa Summer Study generally endorsed both the overall space program of the nation and the management, by NASA, of scientific research in space.[8]

Although these statements concerning the results of the 1962 Summer Study reflect general support of NASA's activities, the National Aeronautics and Space Administration itself pointed out that complete agreement with its official position could not be expected. NASA's review of the 16-chapter report issued by the Iowa Study revealed that "63% of the recommendations in the report are included in NASA's planning and thinking."[9] In addition, the space agency stated that it would be willing to accept, in principle, another 17%. Taking into account the fact that 8% of these proposals pertained to organizations other than NASA, only 5% of the total number of some 130 proposals remained which NASA believed "to be inherently unsuitable for its current program and its long-range thinking in space activities."[10]

In contrast to the general review of scientific research in space of the 1962 Summer Study at the University of Iowa, the objectives of the Space Science Summer Study held in 1965 at Woods Hole, Massachusetts, were more limited. The tasks assigned to this latter study, concerned

---

[8]Minutes of the Eleventh Meeting, October 18, 1962, Space Science Board, Washington, D. C.

[9]Comments on A Review of Space Research, National Aeronautics and Space Administration, Washington, D. C., May 15, 1963, p. 2.

[10]Ibid.

with the post-Apollo period, were: (1) to develop a program of planetary exploration; (2) to recommend an order of priority for this program; (3) to determine the requirements of astronomy in regards to space; and (4) to consider the role of man in space research.[11]

Discussions concerning this second summer study arose, in the fall of 1964, between members of the Space Science Board and the National Aeronautics and Space Administration. Some plans were formulated in February of 1965 by the chairmen of the individual working groups, under the auspices of the Study's general Chairman, George Woollard. In some instances, even before the actual gathering that summer, preliminary meetings were held and assignments made so that some participants arrived with prepared papers. To this end, NASA "made available for advance distribution to all participants a variety of background information that provided a standard point of departure."[12]

Subsequently, plans were developed, and scientists expert in a number of disciplines met at Woods Hole during June and July of 1965. The Study was divided into two sessions consisting of two weeks apiece; the first, June 20-July 3, was primarily concerned with astronomy and the second, July 5-July 16, dealt with planetary and lunar exploration. Two planning sessions were held to discuss the results and recommendations.[13]

---

[11] Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1965, Washington, D. C., p. 98.

[12] Report of the 1965 Summer Study, Space Research: Directions for the Future, Space Science Board, Washington, D. C., 1965, pp. iii-iv.

[13] Ibid.

Space Research: Directions for the Future contained these detailed recommendations, from the scientific community's point of view, of the direction which the national space program should take in the period extending to 1985. Some of the conclusions of this 1965 Summer Study which the Space Science Board chose to emphasize were:[14]

> -- Planetary exploration is the most rewarding scientific objective for the post-Apollo period.
>
> -- A reasonable balance between lunar and planetary programs is desirable.
>
> -- An order of importance within the planetary program is established.
>
> -- A need for large orbiting telescopes is projected.
>
> -- Exploration of space requires the utilization of both ground-based observations and space experiments.
>
> -- The distinction between manned and unmanned programs is an artificial one; scientific objectives should be the determining factors.
>
> -- An orbiting research facility for the study of long-term effects of space flight is essential.

Space Research: Directions for the Future proved to be of great value to the National Aeronautics and Space Administration, as have been all the other major reports of the Space Science Board. NASA employed the 1965 Summer Study documents in testimony before Congress, which itself has made use of these reports in its deliberations. In general,

---

[14] Ibid.

NASA agreed with both the scientific objectives and the means of accomplishing these projects as proposed by the Summer Study reports. The principal areas of disagreement between the space agency and these recommendations of the Board apparently arose where NASA felt that "the level of effort recommended by the report is too high in a given area with respect to the rest of the program or where we are unable to support the level recommended because of budget constraints."[15]

The National Aeronautics and Space Administration, while agreeing that "the research outlined in the reports should be done," stated in the spring of 1966, however, that "NASA cannot, at this time, undertake more than a small fraction of the new projects outlined."[16] NASA therefore urged that careful consideration be given to the sequence and priorities of these projects and explained its reasons as follows:[17]

> The existence of several highly desirable but complex and expensive projects, the uncertainties in the overall NASA budget, together with the need to maintain a balanced program in space science, make it imperative that NASA give careful thought to the priorities of these projects.

---

[15]Report of the National Aeronautics and Space Administration, Comments on "Space Research - Directions for the Future," Washington, D. C., April 1966, p. S-2 and p. S-3.

[16]Letter from Homer Newell, Associate Administrator for Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C., April 7, 1966, p. 1.

[17]Ibid., p. 2.

PART II. THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CHAPTER VIII - NASA ESTABLISHMENT

The formal structure of the National Academy of Sciences' Space Science Board and the manner by which this body of eminent scientists advises the Federal Government have been the subjects of the preceeding chapters. It became apparent, as the history of the Board was traced, that its activities were directed more and more towards NASA. Therefore, with this background knowledge of the activities and procedures of the SSB, it would appear appropriate to examine the relations of the Board with the National Aeronautics and Spaee Administration in order to ascertain the role that the Space Science Board plays in the civilian space program.

The National Aeronautics and Space Administration came into existence on October 1, 1958, as a result of the National Aeronautics and Space Act of 1958 signed by President Eisenhower on July 29 of that year. The Space Act grew out of a recommendation, contained in the President's message to Congress on April 2, 1958, to create a civilian agency to conduct an accelerated program of space exploration. This proposal had been recommended by the President's Science Advisory Committee, which considered policy problems involving science and technology, under the leadership of Dr. James Killian, Jr.[1]

---

[1] U. S. Congress, Senate, Committee on Aeronautical and Space Sciences, Documents on International Aspects of the Exploration and Use of Outer Space, 1954-1962, Senate Document No. 13, 88th Cong., 1st Sess., 1963, p. 5.

The National Aeronautics and Space Act of 1958, which was the sequel to these events, stated that the objectives of the U. S. exploration of space "shall be conducted so as to contribute to one or more of the following national goals":[2]

> (1) The expansion of human knowledge of phenomena in the atmosphere and space;
>
> (2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles
>
> (3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;
>
> (4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
>
> (5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere.
>
> (6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control non-military aeronautical and space activities, of information as to discoveries which have value or significance to that agency;
>
> (7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and
>
> (8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.

---

[2]See: NASA Historical Staff, Historical Sketch of NASA, National Aeronautics and Space Administration (Washington, D. C., 1965), pp. 7-8.

Almost two thirds of these basic goals can be interpreted as lying within the realm of the activities of the Space Science Board which had been established in June 1958 in anticipation of the formation of NASA. Hence, with the enactment of the Space Act, the Board was destined to serve an important role in the national space effort, although the SSB was not itself directly involved in the creation of NASA.[3]

On the other hand, the National Academy of Sciences, of which the Space Science Board is a part, did play a role in the formation of the space agency. Dr. Killian, who had recently been appointed by President Eisenhower to the post of the President's Special Assistant for Science and Technology, asked the advice of, among others, Dr. Detlev Bronk, who was the President of the Academy, concerning the establishment of such a civilian organization.[4]

Similarly, individual members of the Space Science Board also supported the concept of a civilian agency. In fact, the notion of a civilian space establishment had been formulated by scientists, who were to become involved with the SSB, even before SPUTNIK I--which itself predated the Board. This interest in a civilian agency can, in fact, be traced back to Naval Research Laboratory scientists such as Dr. Homer Newell, who were employing sounding rockets to engage in scientific research in space.[5]

---

[3]Interview with Hugh Odishaw, Executive Director, Space Science Board, August 2, 1966.

[4]J. Stefan Dupre and Sanford A. Lakaff, Science and the Nation, Policy and Politics (Englewood Cliffs: Prentice-Hall, 1962), p. 163.

[5]Interview with Homer Newell, Associate Administrator for Space Science and Applications, National Aeronautics and Space Administration, July 27, 1966.

The new space agency was composed of the old National Advisory Committee for Aeronautics (NACA); NASA inherited 7,000 NACA employees, including Hugh Dryden, who had been Director of NACA, as well as its laboratories and field stations. In addition to the NACA personnel, the new space agency also inherited the Vanguard team of the Navy. Also, by virtue of an Executive Order signed on October 1, 1958, NASA received a number of space projects from the Advanced Research Projects Agency of the Department of Defense. Thus, NASA began work with a program consisting of not only the Vanguard satellite but also a lunar probe and a large single chamber rocket engine.[6]

The early activities of the space agency, involving the projects transferred to NASA, employed either ARPA or military personnel. The Department of Defense, in addition to its own space launches, "performed the actual work on five of the eight NASA-directed shots in fiscal year 1959."[7] The Air Force managed the first two Pioneer launches, while the Army launched PIONEERs III and IV. In fact, the very first Pioneer shot was launched October 11, 1958--only ten days after NASA came into existence![8]

At the same time that the National Aeronautics and Space Administration was acquainting itself with the nation's program in space, so was

---

[6]U. S. Congress, House, Committee on Government Operations, Government Operations in Space, House Report No. 445, 89th Cong., 1st Sess., 1965, p. 50.

[7]Ibid., p. 52.

[8]Interview with J. Allen Crocker, Deputy Director, Program Review and Resources, Office of Space Science and Applications, National Aeronautics and Space Administration, July 25, 1966.

the Space Science Board. The main impact of the Board was on the geophysical aspects of the early NASA program; this was the field in which many of the Board members had been most active, especially in the U.S. National Committee for the IGY.[9]

Perhaps the first topic of discussion between the National Aeronautics and Space Administration and the Space Science Board, and one that still remains of primary importance, concerned the extent of liaison between the two organizations. For, without a proper understanding of the activities of each other, the advice of the Board might be based on insufficient and possibly incorrect information, as well as run the risk of being unheeded. Thus, in December of 1958, Dr. Keith Glennan, the first NASA Administrator, asked Dr. Dryden, NASA's Deputy Administrator, to concentrate his attention on NASA's program of scientific research in space, "which would involve extensive liaison with the Space Science Board of the National Academy of Sciences."[10]

This assignment was carried out by Dr. Dryden, who was also Home Secretary of NAS, until his death late in 1965. In addition, Dr. Glennan as well as his successor James Webb, and Dr. Newell have all played an extremely important role, on behalf of NASA, in providing for adequate liaison with the Space Science Board. This has in turn led to the successful and close relationship which exists between these two organizations.[11]

---

[9] Interview with Homer Newell, July 27, 1966.

[10] Robert L. Rosholt, An Administrative History of NASA, 1958-1963 (Washington: NASA, 1966), p. 65.

[11] Interview with James E. Webb, Administrator, National Aeronautics and Space Administration, September 9, 1966.

CHAPTER IX - NASA LIAISON

Immediately following its establishment, the National Aeronautics and Space Administration contacted the Space Science Board through Dr. Homer Newell to request advice on the development of plans for the national program of scientific research in space. Consequently, on November 4, 1958, the Space Science Board formally transmitted the documents it had developed by that time concerning space research. This information included reports--previously discussed regarding the Board's second meeting--by Dr. Porter, concerning short-range program recommendations, and by Dr. Van Allen, summarizing high-altitude rocket research. Also included for submittal to NASA were the proposals to the Space Science Board as a result of the latter's appeal, by telegram, to the scientific community for experiments. Finally, in order to bring the space agency up to date on the discussions of the Board, the minutes of the SSB committee meetings were also submitted.[1]

These documents were supplemented one month later by a Memorandum Report issued by the Board on the first of December. This report contained "recommendations of the Academy's Space Science Board for projects which the Board considers merit earliest attention."[2] These recommendations

---

[1]Letter from Hugh Odishaw, Executive Director, Space Science Board, November 4, 1958.

[2]Letter from Hugh Odishaw, December 2, 1958.

were gratefully acknowledged by NASA's Administrator, Keith Glennan:[3]

> We appreciate very much the interests of the members of the Space Science Board and their very important contributions to the formulation of a sound scientific program. We look forward to continued cooperation of the Board in advising us on this aspect of the activity of the National Aeronautics and Space Administration.

This letter to the SSB Executive Director, Hugh Odishaw, also stated NASA's intention to have Dr. Dryden and Dr. Newell meet with the Board, to discuss NASA's program as soon as it was finalized. As a result of this overture, the Board promptly responded by inviting the top-level representatives of the space agency to the fourth meeting of the Space Science Board at Cape Canaveral during January of 1959. Two important matters were to be discussed at this gathering. The first concerned "the formulation of the more complete report of the Board on the scientific requirements of future space programs."[4]

The second matter mentioned in this letter to the Administrator of NASA dealt with the contributions of the United States to the international program of COSPAR. The Committee on Space Research had been established the previous November under the sponsorship of the International Council of Scientific Unions. The Board thus intended to

---

[3]Letter from Keith Glennan, Administrator, National Aeronautics and Space Administration, December 23, 1958.

[4]Letter from Lloyd Berkner, Chairman, Space Science Board, December 30, 1958.

establish a pattern for fulfilling its role concerning the international scientific community by considering, at its coming meeting, the formulation of a national report to COSPAR on the part of the United States. The Space Science Board therefore felt that it was "important that the responsibilities of the several agencies inevitably involved in this international program should be sorted out at this time."[5]

Another means by which relations between the Space Science Board and NASA have been solidified; besides participation of top-level NASA personnel at actual Board meetings, has been through more informal gatherings between these liaison representatives and Board members. One such meeting was held by NASA on February 12, 1960, at which time Dr. Odishaw presented the requirements of the Space Science Board in order to comply with a work request from NASA. The decisions made at this particular meeting to comply with the needs of the Board were:[6]

(1) NASA Headquarters would prepare the documents requested for SSB.

(2) Copies for SSB and its committees would be given to Dr. Odishaw.

(3) NASA committee members and liaison representatives will be given copies directly.

The NASA Space Science Board committee members present at this gathering represent another facet of liaison between the two organizations, although at a lower level than described above. This method

---

[5] Ibid.

[6] Henry Straus, Meeting of NASA Space Science Board Committee Members and Liaison Representatives, February 12, 1960, Washington, D. C., p. 2.

provides for representation from the space agency to partake in deliberations of the various committees of the SSB in order to keep both NASA and the Space Science Board informed of developments concerning the two. This type of liaison, discussed previously when the Board organization was described, functions similarly to the description of the participation of analogous NASA representatives at the Summer Studies supported by the Space Science Board.

Other means exist by which the SSB initiates the responsibility of remaining in close touch with NASA's program. Liaison is afforded at the upper levels of these two organizations by the attendance of Board members at formal reviews of major programs conducted annually by NASA throughout the year. In December of 1963, for instance, NASA Administrator James Webb urged SSB Chairman Harry Hess to attend these program reviews:[7]

> Dr. Dryden, Dr. Seamans and I are most anxious that persons such as yourself have the greatest possible understanding of the NASA programs, consistent with the great demands which we made upon your time in the conduct of your own activities... we believe your interest would cover the breadth of our program and would be most pleased to add you as a permanent guest.

At lower echelons even another form of liaison, extended on behalf of the Space Science Board exists: representatives of the Board serve as members of the advisory subcommittees of NASA's Space Science Steering Committee. The Space Science Steering Committee (SSSC) was established by NASA to advise, both directly and through its subcommittees,

---

[7] Letter from James Webb, Administrator, National Aeronautics and Space Administration, December 18, 1963.

the Associate Administrator for Space Science and Applications, Dr. Homer Newell.[8] The advisory subcommittee were formed in a number of different scientific areas to provide advice on "NASA's present and future space science activities as follows ':[9]

(a) Reviews scientific proposals as requested by its Chairman;

(b) Recommends space science goals and space science missions;

(c) Recommends general scientific activities and broad areas of supporting research to be conducted in NASA's Space Science Program;

(d) Recommends the investigations to be conducted on the various flight missions;

(e) Alerts the Space Science Steering Committee to deficiencies in the space science program;

(f) Reviews its portion of the short range document 'NASA Program Planning in Space Science' as developed in the office of the Division Director responsible for the programs; and

(g) Prepares its section of the 'NASA Long Range Space Sciences Thinking Document.'

This close relationship between the Board and the scientific subcommittees of the SSSC had been suggested by Dr. Dryden in a letter to Dr. Berkner dated October 25, 1961, which discussed ways of developing more constructive working arrangements between NASA and the Space Science Board. This proposal was included among a number of

---

[8]Interview with Margaret Beach, Space Science Steering Committee Secretariat, July 25, 1966.

[9]National Aeronautics and Space Administration, Space Science Steering Committee and its Advisory Subcommittees, A Management Instruction, April 29, 1964, p. 2.

suggestions to strengthen NASA-SSB liaison:[10]

> We would also welcome a closer working relationship between the Board's committees and our own Space Sciences Steering Subcommittees. There is already some common membership, but it appears that this could well be strengthened. Perhaps it would be worth discussing this point in the near future when we have an opportunity to do so.

The Board responded on the first day of the following December by promising to enact this suggestion as soon as the Board's reorganization was completed. In his reply, Dr. Berkner went even further by proposing that the plan be combined with a desire to improve working relations between NASA and the Secretariat of the Board. Dr. Berkner's suggestion entailed designating a member of the Secretariat staff for direct liaison with the chairmen of the Space Sciences Steering Committee's subcommittees. The Chairman of the Academy's Space Science Board summarized his reasons when he asserted that "such participation would be mutually beneficial because, to a large extent, they must be the channel for keeping Board members and committees informed about NASA programs and plans." [11]

This amendment was approved by Dr. Dryden on December 19 and forwarded to Dr. Newell and Dr. Odishaw for discussion of specific assignments.[12] Subsequently, Dr. Newell concurred in the proposed

---

[10]Letter from Hugh Dryden, Deputy Administrator, National Aeronautics and Space Administration, October 25, 1961, p. 3.

[11]Letter from Lloyd Berkner, December 1, 1961, p. 3.

[12]Letter from Hugh Dryden, December 19, 1961.

assignments, which were then inaugurated along with a further recommendation that specific Board members serve as liaison to the SSSC subcommittees.[13]

The members of the SSSC subcommittees, regardless of their association with NASA, report directly to their respective chairmen These subcommittee chairmen, all of whom are NASA personnel, are responsible for communicating to the Chairman of the Space Sciences Steering Committee. The SSSC Chairman, who is the Director of Science in the Office of Space Science and Applications (OSSA), reports in turn, directly to the Associate Administrator for Space Science and Applications. Thus, the SSSC recommendations are submitted to Dr. Newell for his consideration.[14]

These proposals of the Space Science Steering Committee finally evolve, annually, in the form of a discipline-oriented report, entitled Space Science and Applications Program. This document is intended to furnish summaries of all approved scientific space research, whether experimental or theoretical, on a discipline basis. More specifically, the introduction to this report states:[15]

> Included within each discipline or program section will be a summary statement of objectives, a review of the techniques and instrumentation, and a detailed listing of the flight investigations and supporting research. In the detailed listings will be capsule descriptions of the investigations or

---

[13]Letter from Hugh Odishaw, January 17, 1962.

[14]Interview with Margaret Beach, July 25, 1966.

[15]National Aeronautics and Space Administration, Space Science and Applications Program, December 1965 Edition, Washington, D. C., p. i.

> supporting research, the names of the several investigators and their corresponding affiliations, and an indication of each discipline having primary concern or secondary interest in the outcome of the investigation. The satellite and space probe listings will be by projects, the sounding rocket and other flight experiments will be in numerical order by launch vehicle, and the supporting research will be in numerical order and by NASA Center.

The Office of Space Science and Applications is actually parallel to the Space Science Steering Committee and its Advisory Subcommittees in administrative organization.[16] Dr. Newell, as head of OSSA, thus serves as an important link between the Space Science Board of the National Academy of Sciences and NASA. To fulfill this responsibility Dr. Newell provides the Board with a formal review of space research activities and plans under the title Report to the Space Science Board on the Space Science and Applications Program.

This document developed out of a more formal response on the part of Dr. Newell to brief the Space Science Board on NASA's program of space research. As pointed out previously, this briefing was first presented orally at Board meetings by Dr. Newell: At the sixth meeting of the SSB in October 1959, Dr. Newell presented, on behalf of Dr. Dryden, "the NASA space science program summary."[17] Subsequently, NASA anticipated

---

[16]National Aeronautics and Space Administration, Conduct of Space Science Program - Selection and Support of Scientific Investigations, A Management Instruction, April 29, 1964, pp. 1-2.

[17]Minutes of the Sixth Meeting, October 23-24, 1959, Space Science Board, Washington, D. C., pp. 2-3.

the desire of the Board for such briefings and hence began to prepare this Report to the Space Science Board on the Space Science and Applications Program.[18]

Another NASA publication employed by the Space Science Board to acquaint itself with the space agency's effort in the field of scientific investigation in space is the OSSA Prospectus. This is an annual document, evolved over a number of years, which represents proposed OSSA plans concerning program activity as far in advance as two decades:[19]

> The Office of Space Science and Applications (OSSA) deliberately keeps forward thinking flexible, and subject to adjustment as long as possible, to permit ready incorporation of the new knowledge coming from earlier programs and to allow rapid re-direction to exploit significant scientific breakthroughs.
>
> While OSSA line management carries on forward thinking throughout the year, it annually consolidates this thinking into an internal document known as the OSSA PROSPECTUS. Such consolidation allows the positive relating of flight mission planning to goals and objectives. Publication disseminates this thinking to others in the space program for use and critique. Such interaction serves to improve and sharpen future issues. It is emphasized that the OSSA Prospectus does not constitute an approved program. It is, instead, a listing of future program objectives and opportunities which organizes and stimulates thinking and which contributes to the later definition, selection and approval of future programs.

---

[18] Interview with J. Allen Crocker, Deputy Director, Program Review and Resources, Office of Space Science and Applications, National Aeronautics and Space Administration, July 25, 1966; and interview with Homer Newell, Associate Administrator, Office of Space Science and Applications, National Aeronautics and Space Administration, July 27, 1966.

[19] National Aeronautics and Space Administration, The OSSA Prospectus Records of the Office of Space Science and Applications, Report before the Subcommittee on Space Sciences and Applications, Committee on Science and Astronautics, House of Representatives, Washington, D. C., 1965.

CHAPTER X - SCIENTIST-ASTRONAUTS

As the last chapter in this section, and as a prelude to the final section, this is an appropriate place to discuss an example of the working relations between the Space Science Board and the National Aeronautics and Space Administration. The inclusion of a scientist, trained as an astronaut, in the space agency's program of manned exploration of space was recommended by the 1962 Space Science Summer Study. At this Summer Study the Working Group on Man as a Scientist in Space Exploration examined this role of man from a number of aspects. Consideration was given to questions of the following type:[1]

> To what kinds of scientific missions will a scientist-explorer make his chief contributions? Can any specific guidance be given in the choice of manned missions, as compared to instrumented missions? If scientists are to go on space missions, what are the requirements for their selection, training, and career development? These questions were posed particularly with respect to (i) the Apollo (manned lunar landing) mission and (ii) later missions, still in the conceptual stage, such as a lunar laboratory, earth-orbiting laboratory, and manned planetary missions. Scientific tasks suitable for the Mercury and Gemini programs, as well as the carrying out of maintenance, repair, and modification of equipment by man were also considered, but less extensively.

The conclusions of this investigation appeared in the report of the 1962 Summer Study, A Review of Space Research. It was apparent from the

---

[1] Report of the 1962 Summer Study, A Review of Space Research, Space Science Board, Washington, D. C., 1962, p. 11-1.

document that careful consideration was alloted to the problem of how best to employ a scientist in manned exploration of space--that is, whether he (or she) should be: (1) a fully qualified and recognized scientist trained as an astronaut; (2) an experienced and mature scientist serving as a passenger; (3) a prominent scientist collaborating from the ground with spacecraft personnel; or (4) an astronaut with scientific observational training.[2]

One of the conclusions reached by this group and related in A Review of Space Research recommended the establishment of an Institute of Space Sciences. This was suggested not only as a means of specifically training scientists as astronauts but also as a way of establishing a center for scientific research in space. The justification for the former reason lies in the precautions envisioned to ensure that the scientific skills of scientists being trained as astronauts would not be impaired.[3]

The main conclusion of the Working Group on Man as a Scientist in Space Exploration, as stated in A Review of Space Research, was that:[4]

> Manned exploration of space promises great scientific return and Apollo can be a fruitful first step in this effort. It is in this overall framework that Apollo has become a national mission of high priority. Although the mission itself is first an engineering enterprise aimed at ensuring that man reach the Moon and return safely, it is also the first step in the manned scientific study of the Moon and the planets.

---

[2] Ibid., pp. 11-9, 11-14, and 11-15.

[3] Ibid., p. 11-3.

[4] Ibid., pp. 11-3 and 11-4 (underline by the author).

> Thus, we conclude that the scientific return from Apollo should be maximized. We further conclude that this end can best be served, without prejudice to reality, by including in the crew a scientist fully trained as an astronaut.

As a result of the recommendations contained in the report of the 1962 Summer Study, as well as subsequent discussions between NASA, the Space Science Board, and the National Academy of Sciences, further plans were eventually developed for including scientists in the crews of the projected Apollo lunar landing missions. In February of 1964 NASA representatives met at the Manned Spacecraft Center with George Derbyshire of the Board's Secretariat to formulate plans for a scientist-astronaut program.[5]

This group represented NASA's Office of Manned Space Flight and its Office of Space Science and Applications (OSSA) as well as the Space Science Board. These participants agreed that Dr. Newell's office (OSSA), in conjunction with the Academy, would define the scientific qualifications for the scientist-astronauts, while the Manned Spacecraft Center would outline other prerequisites. It was expected that OSSA, as well as the Office of Manned Space Flight, would be able to arrive at a complete compilation of qualifications by August 1964, so that recruitment could begin in October. The plan further envisioned that the National Academy of Sciences would "screen and rank applicants for scientific qualifications in January and February 1965."[6]

---

[5]Letter from Homer Newell, Associate Administrator for Space Science and Applications, National Aeronautics and Space Administration, April 16, 1964.

[6]National Aeronautics and Space Administration, Scientist-Astronaut Selection, Report of Joint NASA-SSB Meeting, March 25, 1964, p. 2.

As a consequence of the proposed tasks, Dr. Newell requested the Space Science Board to cooperate with NASA "in defining the scientific qualifications and in screening and ranking applicants in accordance with this joint plan..."[7] The Board's Executive Committee agreed to this, and a meeting was planned for late May between several scientists of different disciplines and representatives of NASA, to implement the assignment.[8]

At the same time, the Space Science Board convened an ad hoc committee to define, for recommendation to NASA, the qualifications for the scientist-astronauts. It was also envisioned that the SSB Committee on Qualifications for and Selection of Scientist-Astronauts would provide advice to the Academy's Office of Scientific Personnel to assist in the screening operation assigned to NAS.[9]

Subsequently, the SSB Committee recommended that the minimum scientific qualifications include a doctoral degree or the equivalent experience in the natural sciences, medicine, or engineering as well as a bachelor's degree. The Committee on Qualifications for and Selection of Scientist-Astronauts also agreed not to exclude, a priori, any scientific discipline from consideration. It was also felt desirable that

---

[7]Letter from Homer Newell, April 16, 1964.

[8]Letter from Harry Hess, Chairman, Space Science Board, April 29, 1964.

[9]Minutes of the Fourteenth Meeting, May 27, 1964, Space Science Board, Washington, D. C. p. 9.

applicants have a "background in the physics and chemistry of rocks and meteorites..."[10]

These agreements between the National Aeronautics and Space Administration, the SSB, and the Academy were revealed at a luncheon meeting with newsmen in Washington on April 30, 1964. Dr. Dryden, as NASA Deputy Administrator, and Astronaut L. Gordon Cooper related that:[11]

> Up to 50 scientists would be selected to train with the Gemini/Apollo astronauts at NASA Manned Spacecraft Center during the summer months. Then, perhaps two years before a lunar landing, NASA would select some persons from the reserve to begin full-time training as crew members for later lunar flights.

The following October, NASA began recruiting, as planned, qualified applicants for the program. The eligibility of the projected 10-20 scientist-astronauts was to be determined with the aid of the guidelines set up by the SSB Committee on Qualifications for and Selection of Scientist-Astronauts. NASA also intended to train the qualified scientists in "a limited space-simulation program designed to familiarize them with space environment and test their ability to withstand physical stresses of space flight."[12]

In testimony before Congress, Dr. Hess, as Chairman of the Space Science Board, reported that over four hundred applications for

---

[10]Report to the Congress From the President of the United States, United States Aeronautics and Space Activities, 1964, p. 94.

[11]NASA Historical Staff, Astronautics and Aeronautics, 1964, Washington, D. C., 1965, p. 158.

[12]Ibid., p. 356.

scientist-astronauts had been submitted by the scientific community. After a preliminary screening by the National Aeronautics and Space Administration, these applications were examined by the Board's Committee on Qualifications for and Selection of Scientist-Astronauts. This ad hoc Committee passed judgment on the applicant's professional qualifications as scientists or as medical doctors.[13]

The Committee's work was actually accomplished by two groups: one considered physical scientists and the other biological scientists. The first group held a session at the Academy on March 8 and 9, 1965, for a preliminary review of the applications, and another meeting at the California Institute of Technology on March 29 and 30 for the final selection of candidates. The second group completed its screening of candidates for recommendation to NASA at its meeting on March 8 and 9 at the National Academy.[14]

Although Board members were disappointed in the small number of applications submitted, they were pleased with the quality of the sixteen scientists recommended for consideration as astronaut candidates. Of these, six were selected by the National Aeronautics and Space Administration for training as scientist-astronauts for the Apollo program.[15]

---

[13]U. S. Congress, Senate, Committee on Aeronautical and Space Sciences, National Goals for the Post-Apollo Period, 89th Cong., 1st Sess., 1965, p. 273. Cited hereafter as National Goals.

[14]Report of the Committee on Scientific Qualifications and Selection of Scientist-Astronauts, Space Science Board, April 1965, p. 1.

[15]National Goals, p. 274.

It is also significant to note that the Board's ad hoc Selection Committee also examined the reasons and proposed solutions for what appeared to be a surprisingly small number of interested scientists.[16] It had been hoped that NASA's scientist-astronaut program would demonstrate to the scientific community the desire to improve the status of scientific research in space.[17] Here again the advisory role of the Space Science Board of the National Academy of Sciences appears; the Board has endeavored to enhance relations between NASA and the scientific community.

---

[16]The Committee reported that the small number of applicants was primarily due not to a lack of interest but rather to a lack of publicity.

[17]William Hines, "Scientist Corps Urged for Astronaut Program," The Evening Star, Washington, D. C., June 12, 1963.

PART III. THE SCIENTIFIC COMMUNITY

CHAPTER XI - DOMESTIC RELATIONS

The scientific community of the United States long generated little interest within the Federal Government. This situation was drastically changed as a result of World War II and the birth of the Nuclear Age; science suddenly became an intense matter of public policy. The resultant consequences of Government support of science, as well as the publicity allotted to the role which the scientific community played during the war, brought many scientists into the public spotlight.

The repercussions of this newly-awarded prestige reverberated throughout the scientific world with more or less effect, dependent upon the particular discipline. In fact, the first noticeable manifestation of the prominence of science, in the formidable realm of space, did not really appear until the International Geophysical Year of 1957-1958. Even at that, it required another event of the caliber of the dropping of the atom bomb to shake space exploration lose from the shackles of obscurity.

The launching of SPUTNIK I in October 1957 once again aroused society from its methodical dream of a scientific enterprise allowed to follow its own natural course, to the image of science as the deliverer of mankind. The effects reached almost all aspects of life in America--from the Federal Government to the local school board. And just as in the previous decade, the public again turned its attention to the scientific community:[1]

> One of the most striking reactions to Sputnik I is an enhancement of the status of natural

---

[1] Vernon Van Dyke, Pride and Power (Urbana: University of Illinois, 1964), p. 16.

> scientists and an increase in their influence over national policy. Within two months President Eisenhower announced the establishment of a new office, the Office of Special Assistant to the President for Science and Technology, and transferred the Science Advisory Committee from the Office of Defense Mobilization to the White House, making it the President's Science Advisory Committee (PSAC).

Some recognized that just as the splitting of the atom presaged the growth of nuclear science, the impact of man's intrusion into space would eventually be felt by the scientific establishment, with greatest effect in the disciplines related to space science. In one generation, then, man has witnessed the intense search for the microcosm of the nucleus and the macrocosm of "this new ocean."[2] The creation of a National Aeronautics and Space Administration thus signified the cognizance of the Federal Government of the Space Age, while the formation of the Space Science Board of the National Academy of Sciences demonstrated the awareness of the scientific community.

There is hardly a doubt, among those who are well acquainted with the activities of the space agency and of the Board, that the latter has facilitated relations between NASA and the scientific community.[3] By the same token it may be asserted that, over all, the SSB has been highly successful in its endeavors[4]--from the viewpoint of NASA, of the scientific community, and of the Board itself.

---

[2]President John F. Kennedy. Speech delivered at Rice University, Houston, Texas, September 12, 1962.

[3]See for instance: Robert Rosholt, An Administrative History of NASA, 1958-1963 (Washington: NASA, 1966), p. 68.

[4]Interview with James E. Webb, Administrator, National Aeronautics and Space Administration, September 9, 1966.

This function of the Space Science Board as liaison between the scientific community and the National Aeronautics and Space Administration is regarded as an important aspect of the national space effort. The significance of this function is demonstrated by the following dialogue between Senator Clinton Anderson, Chairman of the Senate Committee on Aeronautical and Space Sciences, and Lloyd Berkner:[5]

> THE CHAIRMAN. And would you comment on the support for the U.S. space program among the scientists represented by the National Academy of Sciences? Would you comment on how the scientists support or fail to support the U.S. space program? Are they reasonably well satisfied with the space program as you see it?
>
> DR. BERKNER. As you know, I was Chairman of the Space Science Board for many years prior to the time I had this heart attack and Dr. Hess took over. It is my opinion that there has always been very close collaboration between NASA and the Space Science Board and in all important respects the recommendations of the Academy as represented by the Board have indeed been carried out in one form or another by the National Aeronautics and Space Administration.
>
> Dr. Hess may wish to comment further on this point.
>
> THE CHAIRMAN. Well, I am glad to hear you say that. I go back to the days when we had to have some very fine scientific testimony on the detection of nuclear explosion and the Berkner report was our most valuable document I thought, and we had fine cooperation from scientists and engineers at the AEC and the Joint Atomic Energy Committee. I just want to be real sure that this same sort of general support is going on for the space effort. I think it is. I just wanted your confirmation that it is.
>
> DR. BERKNER. I do indeed...

Aside from the invaluable service provided by the Board, that of advising NASA on matters of scientific space research, the SSB acts as

---

[5] National Goals, p. 250.

a means of gaining input from NAS and the scientific community:[6]

> ...the participation of the scientific community in the activities of interest to NASA through the mechanism of the Space Science Board continues to be most constructive and helpful.

At the other end of the spectrum, the Space Science Board has admirably served the needs of science in general:[7]

> The Board has provided advice and recommendations on a variety of subjects relating to basic research; it has served to represent the interests of scientists broadly; and it has sought to provide a broad scientific base for current and future United States space science efforts by stimulating the interests of leading scientists in space and by affording a forum for discussion of research problems by the scientific community.

Examples of the first function of the Board listed above--that of advising and recommending--have been discussed throughout. Recall, for example, the Board's historic request by telegram for proposals from the U. S. scientific community concerning scientific research in space to succeed the satellite and rocket program of the IGY.

This event,of course, also falls into the second role of the Board as described above--that of representing science. The Board has fulfilled this purpose many times in its activities with the National Aeronautics and Space Administration. For instance, in 1964 the space agency had compiled a list of scientists to analyze and interpret the data from the

---

[6]Letter from Homer Newell, Associate Administrator for Space Science and Applications, April 24, 1964.

[7]Lloyd Berkner and Hugh Odishaw (eds.), Science in Space (New York: McGraw-Hill, 1961), p. 432.

RANGER VII mission. NASA incorporated the advice of the Space Science Board, as a representative of the scientific community, in order to augment this distribution list.[8]

Another example occurred in 1963 when, responding to a request from the National Aeronautics and Space Administration, the Board "recommended appointment of scientists as advisors to the U.S. members of the working groups which were designated to devise plans for cooperation between this country and the Soviet Union in space research."[9]

The Board has also represented the interests of scientists with respect to Government agencies other than NASA. In fact, in 1961 the Space Science Board presented the opinion of scientists throughout the nation on regulations suggested by the Federal Aviation Agency to regulate the launching and flights of rockets and balloons. The Board solicited these views of the scientific community and issued a special report summarizing the results which was then forwarded to the FAA. The SSB followed this through by aiding the Federal Aviation Agency in revising its original draft regulations and, "in arranging that representative scientists should participate in a hearing on this matter before the FAA..."[10]

The last of the Board functions, cited previously and often in the President's report on U. S. activities in space, concerns the stimulation

---

[8]Letter from Homer Newell, August 25, 1964.

[9]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1963, p. 93.

[10]Ibid., 1961, p. 69.

of basic science. The importance of this function is entwined within the national space effort which could not succeed without the support of leading scientists. This is, in fact, a basic reason for the existence of the Space Science Board. For one thing, NASA relies heavily on the advice of the Board to support its program before Congress and the nation, as evidenced by the careful consideration afforded the Board's recommendations. Another facet which demonstrates the significance of this function is contained in a speech given by Lloyd Berkner at the First National Conference on the Peaceful Uses of Space, held at Tulsa, Oklahoma, on May 27, 1961:

> Since, as space activity becomes more difficult and advanced, the space effort will be limited by our knowledge of space at any time, leadership in space science must soon become one of the controlling factors in acquiring space leadership generally.

In some respects NASA also believes that the Space Science Board functions effectively in the national interest by acquainting the scientific community with its policies and activities.[11] Yet, the Board goes even beyond this role by actively encouraging the participation of the scientific community in the national program of the investigation of space. The reasons for this are found not only in Dr. Berkner's speech to the Conference on the Peaceful Uses of Space, but also in the

---

[11] Interview with Jack Posner, Program Review and Resources, Office of Space Science and Applications, National Aeronautics and Space Administration, July 22, 1966.

following description by Dr. Berkner of how the Board strives to accomplish its work:[12]

> To insure the development of United States space science on a broad base, we ... encourage the participation of scientists from universities and private research institutions. While Government participation is essential, we feel that it would be unwise if space science were to be developed entirely within the bounds of Government activity.
>
> We ... also encourage broad representation from all fields of science in order to offer useful guidance to all groups engaged in space science research ...

One of the means by which the SSB seeks to fulfill this goal is by sponsoring symposia, often in conjunction with other organizations. In April 1959, for example, a symposium on the exploration of space was convened in Washington. This meeting, jointly supported by the Board, NASA, and the American Physical Society and attended by close to a thousand scientists, "reviewed space research findings to that time and discussed the broad objectives of future research programs in all fields of space science."[13]

The Space Science Board has always felt a strong responsibility to encourage not only the scientific community but also the National Aeronautics and Space Administration on the subject of basic research. In

---

[12]"Scientists Form Space Unit of 16," New York Times, August 3, 1958.

[13]Report to Congress from the President of the United States, U. S. Aeronautics and Space Activities, January 1 to December 31, 1959, P. 52.

March of 1961, the Board released its policy paper entitled Support of Basic Research for Space Science which, as previously mentioned, established a precedent in this area for the SSB.

In fact, even before these statements were available, the Board expounded its position to the space agency in February 1961:[14]

> Fundamentally it is the Board's view that a new approach in providing support for basic research in broad areas related to space science is needed to ensure the future availability of well-conceived and worthwhile space experiments.
>
> In the absence of stimulation and support, potential experimenters have not yet been inspired to think about the primary experiments which should be examined. A great deal of ingenuity requiring inspiration of first-rate scientific talent must first be stimulated before new concepts of space experimental approaches and alternatives can be expected to emerge.

Support of Basic Research for Space Science urged the implementation of a broad and imaginative program involving fundamental research in collaboration with the U. S. scientific community. The Board also pointed out that the participation of universities throughout the country was essential for future support of the national program of scientific exploration of space.[15]

The National Aeronautics and Space Administration has also believed very strongly in the policy of encouraging the participation of the academic world. This has been, in fact, a personal policy of NASA

---

[14]Letter from Lloyd Berkner, Chairman, Space Science Board, February 27, 1961.

[15]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1961, p. 68.

Administrator James Webb. It is realized that the universities of this country "contribute substantially to the quality of the space research program both by participation and as a source of scientifically trained people."[16]

The Space Science Board has endeavored to aid NASA on this subject by convening an ad hoc committee to consider the support that the space agency has provided for these institutions. This Committee, as well as a subsequent review by the Working Group on NASA-University Relationships of the 1965 Summer Study, endorsed NASA's Sustaining University Program while at the same time offering its recommendations.[17]

---

[16] Ibid., 1965, p. 100.

[17] Ibid.

CHAPTER XII - WEST FORD[1]

The various functions of the Space Science Board in the scientific community may perhaps best be exemplified by Project West Ford. The Board, since its establishment, had attempted to represent the interests of science during the planning and enactment of this scientific experiment by advising the Government on behalf of the scientific community. The Space Science Board also believes that West Ford aroused scientific interest in space while at the same time encouraging similar fundamental research. The SSB carefully examined this project to determine if it would interfere with other scientific research, for "one of the chief concerns of the Board is the preservation and improvement of scientific standards and opportunities in space research."[2]

The origin of Project West Ford may be traced to W. E. Morrow, Jr., of the Lincoln Laboratory of the Massachusetts Institute of Technology, who proposed a passive communications system consisting of orbiting dipoles. In general, passive satellites are important because of their inherent simplicity and their availability to many users. The technique of scattering microwave energy from a large number of dipoles has

---

[1]For a recent evaluation of the effects of this project, see Irving I. Shapiro, Science, December 16, 1966.

[2]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, January 1 to December 31, 1963, p. 93.

the further advantage that only two orbiting belts, one polar and one equatorial, are required to achieve worldwide coverage.[3]

More specifically this communications experiment was designed to place 35 kilograms of hair-like copper strips in a short-lived belt around the earth. The scatterers were to be resonant at about 8000 megacycles to reflect radiowaves of the same frequency. It was planned to uniformly distribute about 3.5×10^8 of these dipoles along the orbital path until a narrow belt was formed at an altitude of a few thousand kilometers. This orbital height was chosen "to ensure that solar radiation pressure effects will act to produce an ever increasing eccentricity in the orbit, thus bringing perigee into the atmosphere within a few years with consequent belt destruction."[4]

The Space Science Board was informed of the proposed experiment in the fall of 1959 by the Director of the MIT Lincoln Laboratory, who requested the Board to determine such a project's effect on any field of basic scientific research. As a result the Board organized an ad hoc committee in late December of 1959 to investigate the consequences of such an experiment. This committee, as well as a number of study groups, met during the following year to assess any impact which West Ford might have on such fields as atmospheric and ionospheric physics as well as radio and optical astronomy. As a result of these studies, the Board

---

[3]Hugh Odishaw (ed.), The Challenges of Space (Chicago: University of Chicago, 1962), p. 51.

[4]Space Science Board, A Summary Report on Project West Ford, Washington, D. C., August 11, 1961, p. 2.

submitted recommendations to Lincoln Laboratory and the Government "concerning the conduct of the experiment and has arranged for presentation and discussion of the technical details internationally."[5]

The Space Science Board concluded in June 1960, from the reviews submitted, that: (1) This exploratory test would not have an adverse effect on any branch of science. (2) There was justifiable concern for the interference which an operational system might entail for astronomical observation and that any such plans must protect the interests of astronomical research and of science in general. (3) Full information should be published immediately on the scientific and operational aspects of the initial experiment. (4) Frequency bands for radio-astronomy should be agreed upon internationally in view of the possible interference which could result not only from extensive dipole belts but also from active and even passive communication satellites.[6]

The SSB proceeded to stimulate the dissemination of relevant scientific information concerning Project West Ford throughout the remainder of 1960. For example, it reported to the General Assembly of the International Scientific Radio Union (URSI) in London in September. A thirteen-page article was published in the April 1961 issue of Astronomical Journal, and more than 1400 reprints were distributed to astronomers throughout the international scientific community. In addition, many

---

[5]Report to Congress from the President of the United States, U.S. Aeronautics and Space Activities, January 1 to December 31, 1960, p. 58.

[6]Space Science Board, A Summary Report on Project West Ford, pp. 2-3.

astronomers and observatories were invited to investigate the proposed belt on behalf of the Board.[7]

The Space Science Board, in conjunction with Lincoln Laboratory, also concluded that continued investigation of Project West Ford was advantageous. Therefore, in late July of 1960 the Board established a standing committee of six optical and radio astronomers under the chairmanship of John Findlay of the National Radio Astronomy Observatory. The Committee was requested by the Board "to work closely with project scientists and engineers at the Lincoln Laboratory, to review developments as the experiment progressed, and as far as possible to share its information and findings with the interested members of the world scientific community."[8]

In April 1961, the National Academy of Sciences issued a report which summarized its activities to that time on West Ford. Included in this document was a policy statement on the project from Dr. Jerome Wiesner, Special Assistant to the President for Science and Technology and Chairman of PSAC. It represented the official position of the Federal Government and was prepared by the National Aeronautics and Space Council and approved by the President.[9]

---

[7]Space Science Board, West Ford Statement, Washington, D. C., August 11, 1961, p. 2.

[8]Space Science Board, Background and Summary of Findings, Report on the Optical and Radio Astronomical Effects of the Project West Ford Experiment, Washington, D. C., February 7, 1964, p. 2.

[9]Letter from Jerome Wiesner, The White House, Washington, August 11, 1961.

This policy statement reported that the Government had received the conclusions of astronomers that the effects of the proposed experiment would be harmless. The document further guaranteed that no other attempts would be conducted until after the results of the first one were carefully evaluated. In this respect it listed three guidelines to be followed by the United States Government in conducting Project West Ford: [10]

> 1. No further launches of orbiting dipoles will be planned until after the results of the West Ford experiment have been analyzed and evaluated. The findings and conclusions of foreign and domestic scientists (including the liaison committee of astronomers established by the Space Science Board of the National Academy of Sciences) should be carefully considered in such analysis and evaluation.
>
> 2. Any decision to place additional quantities of dipoles in orbit, subsequent to the West Ford experiment, will be contingent upon the results of the analysis and evaluation and the development of necessary safeguards against harmful interference with space activities or with any branch of science.
>
> 3. Optical and radio-astronomers throughout the world should be invited to cooperate in the West Ford experiment to ascertain the effects of the experimental belt in both the optical and radio parts of the spectrum. To assist in such cooperation, they should be given appropriate information on a timely basis. Scientific data derived from the experiment should be made available to the public as promptly as feasible after the launching.

This Government policy was embodied in the August report issued by the Space Science Board on behalf of the National Academy of Sciences.

---

[10] Project West Ford: U. S. Policy, A Policy Statement of the United States Government, August 11, 1961.

In this SSB statement on West Ford, distributed at the General Assembly of the International Astronomical Union in August, the Board, in light of its own studies as well as the policy of the Federal Government, reiterated in more detail some of its original Committee conclusions of June 1960:[11]

> (1) The Project West Ford experiment will constitute no interference to optical or radio astronomy. As a matter of fact, the belt will be barely detectable, even by astronomers with advance information and upon the taking of special efforts for detection. It is true that a belt or belts could be erected which could cause serious interference to astronomical observations; however, the United States government policy provides that no further launches of orbiting dipoles will be planned until the West Ford results have been analyzed and evaluated and further, will be contingent on the development of necessary safeguards.
>
> (2) The Board will continue its studies of this area of experimentation on behalf of the scientific community. In these studies it will depend on objective and quantitative assessments that constitute the foundation for scientific discussions, recommendations and decisions. These assessments can only be achieved through a carefully controlled, harmless test, and Project West Ford provides a clear opportunity for scientists of all nations to cooperate in making observations to form the basis for an objective understanding of the behavior of an orbiting dipole belt, both in terms of its astronomical properties and of its communication capabilities.
>
> (3) The Board will continue to keep the scientific community everywhere informed and it invites the cooperation and assistance of scientists everywhere who have interest and specialized knowledge in this area. The Board acknowledges with gratitude the assistance of many scientists -- both at home and abroad -- who have already contributed to its studies.

---

[11] Space Science Board, West Ford Statement, p. 3.

It is thus apparent that the work of the Space Science Board on Project West Ford included not only advising the Government but also informing the public. In addition, the Board functioned as a public relations body by identifying the basic issues of concern related to scientific research in space. This role has been underlined by Dr. Wiesner in his book entitled Where Scientists and Politics Meet. The former Special Assistant for Science and Technology under President Kennedy employed Project West Ford as an example:[12]

> I believe that in undertaking such experiments, the government has a responsibility to weigh their importance to our national security or the advancement of science against their possibly harmful effects. I also believe that the scientific community has the responsibility to assist the government in arriving at balanced judgments in these matters and in interpreting them to the general public. In this connection, it is important to emphasize that the problem is complicated by the fact that in addition to the real problems that must be considered, one is confronted with many unfounded allegations ascribing bad effects to experiments that are simply unpopular for some other reason.

In fulfilling these functions the SSB West Ford Committee continued to advise both Lincoln Laboratory personnel and Government authorities. The National Academy of Sciences disseminated relevant calculations on the predicted lifetime of the dipole belt to the scientific community in an article published in the October 6, 1961, issue of Science magazine.[13]

---

[12]Jerome Wiesner, Where Science and Politics Meet (New York: McGraw-Hill, 1961), p. 52.

[13]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1961, p. 70.

A little over two weeks after the article appeared, the West Ford experiment was launched into space. This action evoked some criticism of the Government from some parts of the scientific community. It was reported that provisions had not been included to prevent the capsule from ejecting if it were not in the proper orbit. As it happened the dipole dispenser did not achieve the intended orbit, but fortunately failed to work correctly and the belt of dipoles was not formed.[14]

The influence of the Space Science Board and the concern of the scientific community apparently aided in the redesign of the West Ford package to assuage any doubts about the project. Subsequently, the Board announced, in March 1962, that improvements had been made in the second proposed attempt. These included a reduction in weight which meant 100 million less dipoles as well as a fail-safe device to ensure that the capsule would eject at only the proper orbit.[15]

The second attempt in May 1963 succeeded in establishing a short-lived dipole belt, and subsequently the National Academy of Sciences issued a report of the ad hoc West Ford Committee. It was prepared in

---

[14] The Integrity of Science, A Report by the American Association for the Advancement of Science Committee on Science in the Promotion of Human Welfare, December 31, 1964, p. 12.

[15] National Aeronautics and Space Administration, Astronautical and Aeronautical Events of 1962, A Report to the Committee on Science and Astronautics, U. S. House of Representatives, June 12, 1963, p. 33.

October 1963 on the basis of the available data up to that time, and was approved by the Board at its thirteenth meeting in December. In addition, some 200 copies of the report were distributed to various interested groups by the middle of February 1964.[16]

The "Report on the Optical and Radio Astronomical Effects of the Project West Ford Experiment," released on February 7, 1964, summarized the conclusions of the SSB committee as follows:

> (1) Optical observations of the surface brightness of sunlight scattered by the West Ford belt show that the surface brightness is in no case brighter than that predicted ahead of the event by various astronomers.
>
> (2) The radio reflectivity of the belt was somewhat less than predicted for frequencies near resonance, but was somewhat greater than predicted for emissions in the ultrahigh-frequency region, at least during the first several months of the belt's existence. These facts may be explained by the surmise, supported by considerable additional evidence, that some of the dipoles (probably somewhat more than one-half of the total number) failed in the early stages of the experiment to separate into individual reflectors, but remained loosely tangled in small clusters or chains.
>
> (3) The changes in the orbital elements and the rate of spreading of the dipole belt during the first few months of its existence agree well with predictions computed on the basis of theory that takes into account the resonant interaction of the Earth's nonspherical gravitational field and solar radiation pressure. The predicted lifetime is about three years.

---

[16] Letter from John Findlay, Chairman, ad hoc West Ford Committee, Space Science Board, March 24, 1964.

> (4) The agreement of observation and prediction in all events is good enough to engender confidence that astronomers can predict accurately enough for all practical purposes the astronomical side-effects of experiments similar to West Ford, should any such ever be proposed, given the characteristics of the experiment and those of the observing equipment, whether optical or radio.
>
> (5) With the observing techniques available today, the present experiment has not so far been harmful to optical or radio astronomy.

This document represented the final work of the West Ford Committee, and hence the group was discharged by the Space Science Board at its December meeting. At this meeting the responsibilities of the disbanded West Ford Committee were assigned to the newly organized Committee on Contamination and Interference. This latter group was established in response to the need for a committee with broader responsibilities in this area, and to its international counterpart, the COSPAR Consultative Group on Potentially Harmful Effects of Space Experiments.[17]

---

[17] Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1964, pp. 95-96. Much of the documentation of the 1959-1964 West Ford controversy is contained in International Cooperation and Organization for Outer Space: Staff Report Prepared for the Committee on Aeronautical and Space Sciences, United States Senate (Washington: U. S. Government Printing Office, 1965).

CHAPTER XIII - COSPAR ACTIVITIES

The international activities of the Space Science Board have primarily been in conjunction with the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU). The Board, on behalf of the National Academy of Sciences and with the support of the National Aeronautics and Space Administration, represents the U. S. scientific community on this committee. The Chairman of the SSB Committee on International Relations acts as the delegate from the United States to COSPAR.[1]

COSPAR was established by the International Council of Scientific Unions in October 1958. This action had been recommended to the ICSU--which at that time was considering the formation of such a body--by the Committee on International Relations of the Space Science Board on September 24, 1958.[2] Also in September, Dr. Albert Noyes was designated by the Space Science Board to act as the Academy's delegate to the first meeting of COSPAR in London convened by Dr. Newell, on November 14, 1958. Dr. Richard Porter, who had assisted Dr. Noyes, was subsequently appointed as the U. S. representative to replace Dr. Noyes, who had requested to be

---

[1] Report to Congress from the President of the United States, U. S. Aeronautics and Space Activities, January 1 to December 31, 1960, p. 57.

[2] The full text of the recommendation of the SSB Committee on International Relations, containing this proposal as well as suggestions concerning the structure of a Committee for Space Research, is contained in Appendix 1.

relieved of this post due to other responsibilities.[3]

Dr. Porter represented the U. S. at the second organizational meeting of COSPAR held at The Hague in March 1959. At this meeting, delegates from Australia, Canada, France, Japan, the Union of South Africa, the U.S.S.R., the United Kingdom, and the U. S. advised the international committee on the activities of their respective national scientific institutions in regards to space research. Dr. Porter, on behalf of the U. S., reported on future plans of this country for the scientific investigation of space. He also related an offer, authorized by NASA, to launch into orbit any satellite payloads or individual experiments sponsored by COSPAR as a continuation of the IGY policy of international scientific cooperation.[4]

This policy statement of the United States was a direct contribution to the foundation of the Committee on Space Research which had itself been formed to extend international cooperation in space research along the lines of the International Geophysical Year. COSPAR does not, however, embrace the responsibilities of supporting any particular experimental programs of space research. Yet, it has encouraged as well

---

[3]National Academy of Sciences, National Research Council, Annual Report, Fiscal Year 1958-1959 (Washington: U. S. Government Printing Office, 1960), pp. 82-83; letter from S. D. Cornell, Executive Office, National Academy of Sciences, November 5, 1958.

[4]U. S. Congress, Senate, Committee on Aeronautical and Space Sciences, Documents on International Aspects of the Exploration and Use of Outer Space, 1954-1962, Senate Document No. 13, 88th Cong., 1st Sess., 1963, p. 6 and 103. Cited hereafter as International Documents.

as guided international cooperation and participation in such scientific research.[5]

In support of these activities of the Committee on Space Research, the SSB compiles and annually submits to COSPAR the contributions that the United States has made in the realm of scientific research in space. This national report to COSPAR ordinarily includes accounts of U. S. activities in space research accomplished by NASA, DOD, "other U. S. government agencies, universities, research institutions of all types and U. S. industrial corporations."[6]

The National Aeronautics and Space Administration participates in this role of the Board through liaison representatives to the SSB Committee on International Relations. This Committee is comprised of members from not only the Space Science Board but also the U. S. National Committees of three of the ten Member Unions of COSPAR, as well as the U. S. scientific community in general. In addition, besides NASA, there are liaison members from the Department of State, the Department of Defense, the National Science Foundation, the Federal Communications Commission, and the Office of the Foreign Secretary of the Academy.[7]

The Space Science Board thus represents the United States and the national scientific community through its Committee on International

---

[5]Hugh Odishaw(ed.), The Challenges of Space (Chicago: University of Chicago, 1962), p. 247.

[6]Report to the Congress from the President of the United States, United States Aeronautics and Space Activities, 1962, p. 80.

[7]Space Science Board, A Report Submitted to Walter Gleason, Office of the Foreign Secretary, National Academy of Sciences, December 30, 1965.

Relations. This Committee also arranges for U. S. participation in the various international activities arranged by COSPAR. These include active support not only of the meetings and working groups of the Committee for Space Research, but also in the various symposia and international rocket intervals.[8]

The First Annual International Space Science Symposium was scheduled by COSPAR for Nice, France, in mid-January 1960. The purpose of the scientific gathering was to examine past scientific achievements in space as well as future possibilities in this field. U. S. scientists presented about one half of the papers at this meeting, which was organized into separate sessions on the following subjects: earth's atmosphere, ionosphere, cosmic radiation and interplanetary dust, solar radiation, the moon and planets, meteorites, and tracking and telemetering.[9]

The Space Science Board was host to the Third International Space Science Symposium and the Fifth COSPAR Meeting in Washington, D. C., in the spring of 1962. About twice as many scientists from all over the world attended this meeting as did the first symposium. Aside from the presentation of scientific papers, the following important actions were taken during the COSPAR working sessions: (1) proposal of a series of

---

[8]Lloyd Berkner and Hugh Odishaw (eds.) Science in Space (New York: McGraw-Hill, 1961), p. 433.

[9]U. S. Aeronautics and Space Activities, January 1 to December 31, 1960, p. 63.

internationally coordinated space experiments for the International Year of the Quiet Sun (IQSY) and the World Magnetic Survey (WMS), including plans for satellites, synoptic rocket launchings, and polar cap experiments; (2) establishment of various procedures for the extension and clarification of exchange of information about experiments conducted in space; and (3) establishment of a Consultative Group on Potentially Harmful Effects of Space Experiments.[10]

The first recommendation referred to proposals to take advantage of the period of minimum solar activity predicted for 1964. As a result of these plans the Academy's Geophysics Research Board reconstituted its IQSY Panel into the U. S. Committee for IQSY, as this country's counterpart to the international IQSY Committee. The former Committee worked in conjunction with the Space Science Board to develop proposals for the U. S. program of activities both for the IQSY and WMS.[11]

The Executive Committee of the Board devoted a major portion of its meeting in March 1962 to a discussion of proposed experiments on the part of the United States for the IQSY and WMS. The scientific program of the National Aeronautics and Space Administration was necessarily the

---

[10] United States Aeronautics and Space Activities, 1962, p. 78.

[11] Ibid., pp. 78-79; ibid., 1961, p. 71.

foundation for any U. S. contribution to these world-wide undertakings. In addition, these programs would contribute to the national space effort by providing valuable data in such areas as the forecasting of unusual solar and magnetic events, of great concern to NASA's manned space flight program. It was also recognized that the conduct of the U. S. contributions should demonstrate the high caliber of scientific activity in this country:[12]

> ...our conduct of these programs during the 1964-1965 solar minimum will represent a major and striking contribution to international co-operation in science: the IQSY and WMS have compelling qualities akin to those of the IGY in terms of international relations and great human enterprises.

Another COSPAR area in which the Space Science Board has directed U. S. cooperation are the World Data Centers which provide a means of international exchange of data on scientific exploration of space. These World Data Centers collect results of experiments carried on rockets, satellites,and spacecraft in a variety of geophysical areas such as ionospheric physics, solar activity, geomagnetism, and meteorology. For instance, the World Data Centers served as collection points for the results of sounding rocket experiments conducted during the COSPAR sponsored international rocket intervals such as the ones held in 1960 and 1961.[13]

---

[12]Letter from Lloyd Berkner, Chairman, Space Science Board, March 26, 1962, p. 3.

[13]U. S. Aeronautics and Space Activities, January 1 to December 31, 1960, p. 63.

The Space Science Board supports these World Data Centers and, in particular, provides guidance to the World Data Center A located in the United States.[14] This manner of international cooperation is supported by the National Aeronautics and Space Administration. The space agency's work in cooperation with the SSB is described by Arnold Frutkin of NASA in The Challenges of Space:[15]

> To ensure dissemination of scientific data resulting from space research, procedures are in force within NASA to provide for: dispatch of preliminary technical information to COSPAR upon the launching of rockets and satellites; regular transmittal of orbital elements and satellite observations through the international Spacewarn system designated for that purpose; NASA support of the United States component of Spacewarn; publication of preliminary scientific results and the deposit of results in the World Data Centers; agreements with experimenters to provide the results required; and publication, for world use, of telemetry calibrations where useful.

Another area of international cooperation between the Space Science Board, the Committee on Space Research, and the National Aeronautics and Space Administration has been the United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space. This 18-nation committee was established in December 1958 by the General Assembly to report on:[16]

> ...the activities and resources of the United Nations, its specialized agencies, and other

---

[14]World Data Center B is situated in the Soviet Union and Czechoslovakia, and the third one, World Data Center C, is in Western Europe and Japan.

[15]Hugh Odishaw, The Challenges of Space, p. 275.

[16]International Documents, p. 8.

> international bodies in this field; proposals for coordination of research programs, exchange of information, and organizational arrangements to facilitate such cooperation; and the nature of legal problems related to outer space exploration.

The SSB has provided, in collaboration with NASA, information and advice to this committee on scientific research in space. The Board has also provided, at the request of the Department of State, one of two scientific advisers to the U. S. representative on this U. N. committee.[17] Similarly, COSPAR has also conferred with the United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space.[18]

---

[17] U. S. Aeronautics and Space Activities, January 1 to December 31, 1959, p. 55.

[18] Ibid., 1960, p. 62.

CHAPTER XIV - TERRESTRIAL CONTAMINATION

The subject of space probe sterilization is an outstanding working example of the way in which the Space Science Board of the National Academy of Sciences collaborates with those responsible for the conduct of scientific research in space and, in particular, the international scientific community. The prevention of the contamination of the planets has been of primary concern domestically not only to the Academy but also the National Aeronautics and Space Administration and the Department of Defense. Internationally, deliberations have been convened on this subject by the International Council of Scientific Unions and its Committee on Space Research.

The origins of activities in the United States relating to the contamination of extraterrestrial bodies have been attributed to the NAS. In February 1958 the Council of the National Academy of Sciences adopted a number of resolutions urging that scientific exploration of the moon and planets be conducted carefully and that ICSU investigate the prevention of contamination of such celestial bodies.[1]

Dr. Lloyd Berkner, who at the time was President of the International Council of Scientific Unions, communicated the NAS resolutions to ICSU in

---

[1]Report of the 1962 Summer Study, A Review of Space Research, Space Science Board, Washington, D. C., 1962, pp. 10-11.

March of the same year. Consequently, the Council formed an ad hoc Committee on Contamination by Extraterrestrial Exploration (CETEX). This latter group compiled a report recommending the "adoption of a code of conduct aimed at achieving a compromise between an all-out program of lunar and planetary exploration on the one hand and the desire to provide absolute protection of these objects for future research on the other." [2]

Subsequently, this document was strongly supported by the Space Science Board in conjunction with those agencies, such as NASA and DOD, concerned with the exploration of space. This endorsement was forwarded to the International Council of Scientific Unions through the Director of the NAS Office of International Relations. The concern of ICSU also occasioned the Space Science Board to form a group to define the Board's position on this problem of sterilization.[3]

This special meeting was convened in December 1958 and included representatives of the biological, astronomical, physical, and engineering sciences. These meetings resulted in the establishment of a small ad hoc committee, under the chairmanship of Dr. Joshua Lederberg, to consider the problems involved in the prevention of contamination of celestial objects by space probes.[4]

---

[2] Ibid., p. 10-12.

[3] National Academy of Sciences-National Research Council, Annual Report, Fiscal Year 1958-1959 (Washington: United States Government Printing Office, 1960), p. 83.

[4] A Review of Space Research, pp. 10-13.

Among the conclusions of this committee, which met the first week of July 1959, was the important finding that the techniques required for the sterilization of terrestrial objects were feasible with the expected hardware. Hence, after adoption by the Board, its recommendations were communicated to the Government. Specifically, these proposals were sent to Dr. Keith Glennan of the National Aeronautics and Space Administration and to Mr. Roy Johnson of the Advanced Research Projects Agency. The Space Science Board recommended:[5]

> That an immediate study program be undertaken to determine sterilization requirements for space probes and to develop recommendations, compatible with present design and assembly processes, regarding necessary sterilization procedures;
>
> That procedures be immediately established and implemented to insure a complete inventory of all components of all space probes.

NASA responded by reporting on the steps it had taken on the Board's recommendation. In particular, the space agency related that it had issued instructions to sterilize various payloads being developed by the Space Technology Laboratories, the Goddard Space Flight Center, and the Jet Propulsion Laboratory. Furthermore, this reply stated:[6]

> This Administration agrees with the Space Science Board that a need exists for more factual information concerning the requirements for sterilization of space probes. In recognition of the possibility

---

[5]Letter from Hugh Odishaw, Executive Director, Space Science Board, September 14, 1959.

[6]Letter from Keith Glennan, Administrator, National Aeronautics and Space Administration, October 13, 1959.

> that earth life forms may be conveyed to the moon and the planets via space vehicles, the NASA has adopted the general policy of sterilizing, to the extent technically feasible, all space probes intended to pass in the near vicinity of or impact on the moon or planets.

At the same time, the Space Science Board was also collaborating with the international scientific community through its representatives to COSPAR on the subject of biological contamination. At its meeting in Nice, France, in 1960 the Committee for Space Research had requested "biologists...to undertake experiments to develop basic data for quantitative specifications to be used in decontaminating and sterilizing spacecraft." [7]

Two years later, COSPAR extended its activity to encompass potential problems due to space equipment which may interfere with the scientific space research by establishing the Consultative Group on Potentially Harmful Effects of Space Experiments. This action had been in response to a request from the International Council of Scientific Unions for a world-wide group of scientists to undertake deliberations of such subjects as the prevention of contamination of extraterrestrial bodies.[8]

The Space Science Board reacted to its international responsibilities the following year by forming its own committee to study problems relating to undesirable effects of space research. The Committee on Potential

---

[7]Report to Congress from the President of the United States, U. S. Aeronautics and Space Activities, January 1 to December 31, 1960, Washington, D. C., p. 62.

[8]Report to the Congress from the President of the United States, U. S. Aeronautics and Space Activities, 1962, Washington, D. C., p. 79

As a consequence of the 1962 Summer Study, the Board continued its evaluation of the problems and policies involved in the decontamination of space vehicles. The conclusions attained by the SSB were released in a policy paper on August 5, 1963, which concerned itself specifically to probes of the moon and Mars.[12]

The letter from SSB Chairman Harry Hess to NASA Administrator James Webb, which officially transmitted this paper to the space agency on August 5, suggested that these recommendations of the Board might be employed by NASA in its public statement on space probe sterilization. This proposal was in fact implemented; on September 13, 1963, the National Aeronautics and Space Administration issued "procedures on decontamination of lunar landing spacecraft and planetary landing spacecraft," based on the recommendations of the Board which also were made public.[13]

In more recent years, the Space Science Board has continued to carry out its responsibility in the area of biological contamination by space vehicles, not only on extraterrestrial bodies but also on the earth (back contamination). The Board has fulfilled its advisory role by acting on both domestic and international matters concerning this particular aspect of scientific research in space, in its capacity as a spokesman for the scientific community.[14]

---

[12]Space Science Board, Space Probe Sterilization, A Policy Statement to the National Aeronautics and Space Administration, August 5, 1963. This paper may be found in Appendix J.

[13]NASA Historical Staff, Astronautics and Aeronautics, 1963, Washington, D. C., 1964 , p. 339.

[14]Letter from Frederick Seitz, President, National Academy of Sciences, May 7, 1965.

SUMMARY - PERSPECTIVE

There are a number of observations and conclusions drawn within this paper which should be reiterated at this point. They pertain to the fact that the Space Science Board of the National Academy of Sciences is unique as a scientific advisory body. The Board was organized under the National Academy ; not so much to be an independent body, but more importantly so that it would be a responsible one. In this regard the precedent established by the utilization of in-house scientific advice by the Atomic Energy Commission was not followed in the case of the national space program. In addition, the National Aeronautics and Space Administration not only disregarded the option of creating an advisory body similar to the AEC's General Advisory Committee but also elected not to rely directly on such sources as the President's Science Advisory Committee. The rationale for this decision was that such advisory bodies would be committed either to NASA or to the President and hence might not be able to provide an unbiased scientific opinion.

This point should not be underestimated, for it is probably one of the outstanding reasons for the high repute attributed to the Space Science Board as a source of scientific advice. For one thing, as part of the National Academy of Sciences, the Board truly represents the U. S. scientific community. Although scientists are not in complete accord with the space program, it cannot be denied that their opinions are presented by a representative group of experts on scientific research

in space. The members of the Space Science Board are selected by the National Academy of Sciences, to which the Board is amenable, and not by the National Aeronautics and Space Administration.

According to James E. Webb, NASA Administrator, the fact that the Space Science Board has operated in this manner establishes it among the best institutions for furnishing advice.[1] Moreover, the activities and organization of the Space Science Board constitute an exceptional example of the way in which the Federal Government ought to obtain the responsible opinion of an advisory body. As such the Space Science Board might well serve as a prototype in the establishment of similar consultative groups by organizations similar to the National Academy of Sciences. For instance, there is a proposal being discussed in Washington concerning the creation of a sort of Academy of Administration. It is hoped that a structure such as this might embody a Public Administration Advisory Council to advise the departments, agencies, and bureaus of the Executive Branch on the solution of administrative problems.

Therefore, the Space Science Board, as a unique demonstration of scientific advice responsibly submitted to the Federal Government, might well represent not only an outstanding achievement in the interaction of science and public policy but also a framework for the formulation of similar advisory groups as society becomes increasingly technical and complex.

---

[1] Based on a NASA Historical Interview with Mr. James E. Webb, Administrator, National Aeronautics and Space Administration, Washington, D. C., September 9, 1966.

APPENDIXES

APPENDIX A

SPACE SCIENCE BOARD
National Academy of Sciences
2101 Constitution Avenue
Washington 25, D. C.

Tabulation of Some Board Activities: 1958-1961

Domestic

1. Solicitation, assessment, and assembly into a usable form, involving participation by all Board committees, of approximately 200 space research proposals, as the basis for NASA's initial program following the IGY space research effort.

2. Preparation of an article, "Research in Space", SCIENCE, Vol. 130, No. 3369, July 24, 1959, to acquaint the scientific community with the opportunities and requirements in the use of rocket and satellite vehicles.

3. Preparation and distribution of Academy report in ten chapters entitled "Science in Space"; subsequent to this, revision and preparation of this report for publication in book form by McGraw-Hill.

4. Planning and conduct of symposium on current knowledge and future objectives of research on planetary atmospheres, Arcadia, California, June 1960.

5. Subsequent to planetary atmospheres symposium, development of more thorough study of current knowledge and research opportunities on planetary atmospheres (report soon to be published).

6. Planning and conduct of a small symposium to discuss the potential of radar astronomy techniques in astronomical research with the aim of stimulating interest and exploring the requirements for additional facilities.

7. Organization of a small study group on photo chemical reactions and the far ultra-violet.

8. Organization and conduct with NASA and the American Physical Society of symposium on opportunities in space research, Washington, April 1959.

9. Over period of two years, continuous attention to potential effects of Project West Ford on fundamental scientific investigations. On this topic action was taken to bring scientific aspects of this program widely to the attention of foreign scientists, and advice was provided to the government on many occasions.

10. Preparation and transmittal of Board policy recommendations to government concerning man's role in the national space program.

11. Preparation and transmittal of Board recommendations to government on national needs for strong programs of fundamental research, with particular emphasis on the role of universities in this endeavor.

12. Advice and assistance to NASA to develop sound scientific objectives of planetary and interplanetary research.

13. Expansion of the Board life science activities in line with the deactivation of the NRC Bioastronautics Committee.

14. Preparation of report for NASA outlining the needs for new instrumentation requiring development for the space science program.

15. Organization and conduct of meeting to assess present state of knowledge of fields and energetic particles in space as a first step in the assessment of the radiation problem in manned space exploration.

16. Organization of Board effort and study groups to consider other primary problems of manned space exploration such as gaseous environment, weightlessness, etc.

17. Assessment of the effects of multiple Echo-type balloons on optical and radio astronomy for the AACB unmanned spacecraft panel.

18. Preparation of recommendations to the government, for use at ITU Administrative Radio Conference, Geneva, 1959, of radio frequency requirements for space research. Upon the establishment of the Academy Committee on Radio Frequency Allocations for Scientific Research, designation of Drs. Leo Goldberg and O. G. Villard as SSB representatives to this committee.

19. Preparation and transmission of recommendations to government agencies regarding measures required to avoid biological contamination of the Moon and planets.

20. On behalf of NASA, analysis of the adequacy of satellite tracking and orbital information in terms of scientific needs.

21. Initiation of study to examine problems of space research susceptible of solution by mathematical techniques, information theories, data processing, etc.

22. Stimulation of a national program for the systematic collection, cataloging and analysis of meteorites.

23. Study of the compatibility of nuclear power supplies for use in lunar probes, and development of a policy for government guides.

24. Investigation of opportunities for nuclear propulsion of space vehicles.

25. Study of scientific requirements for a geodetic satellite, including presentation of findings on this topic to the President's Science Advisory Committee.

26. Collection of views and submission to the Federal Aviation Agency of the scientific requirements for consideration in connection with proposed regulations to control the launching of balloons.

27. Planning and conduct of conferences to consider prospects and future directions of research directed toward the detection of extraterrestrial life.

28. Stimulation and support of programs in laboratory astrophysics for space research needs.

29. Continuous surveillance and operation of World Data Center A for Rockets and Satellites, including national and international distribution during the past three years of eleven issues of the Satellite Report series, and six issues of the Rocket Report series.

International

1. From the date of its establishment in October 1958, continuous representation of U. S. programs of space research in the ICSU Committee on Space Research (COSPAR) on which the Chairman of the Board's Committee on International Relations serves as Vice President.

2.. Development of and planning for Academy delegations to four COSPAR meetings including designation of and guidance to U. S. representatives to COSPAR working groups.

3. Development, preparation and submission of annual reports on the U. S. space program for distribution to COSPAR participants.

4. Transmittal through COSPAR of invitation from U. S. Government for foreign scientists to conduct space experiments on board U. S. - launched satellites and space probes.

5. Planning and coordination of some forty-five U. S. scientific papers presented at the COSPAR First International Space Science Symposium, Nice, France, January 1960.

6. Planning and coordination of some fifty-six U. S. scientific papers presented at the COSPAR Second International Space Science Symposium, Florence, Italy, April 1961.

7. Regular transmittal to COSPAR and its adherents of relevant information concerning orbital parameters and descriptions of scientific experiments for each successful U. S. scientific satellite or space probe.

8. Preparation and distribution of world list of optical and radio tracking stations.

9. Development, and international distribution through COSPAR, of bibliography on results of space research from IGY through 1960.

10. Development of revised guide for international exchange of scientific data obtained from rocket, satellite and space probe experiments.

11. Assistance, including revision of communication codes, to COSPAR SPACEWARN system by which prompt information concerning successful satellite and space probe launchings is distributed throughout the world.

12. Coordination of U. S. contributions to annual COSPAR Rocket Intervals.

13. Coordination of U. S. scientific contributions to international COSPAR study regarding geophysical events associated with July 1959 and November 1960 unusual solar-terrestrial activity.

14. Coordination of research interests and contributions of U. S. upper atmosphere scientists in development of COSPAR International Reference Atmosphere.

15. Assistance to the NASA and the U.S. delegation to the U.N. on space science aspects arising from deliberations by the U.N. ad hoc group on Peaceful Uses of Outer Space.

16. Participation by Chairman, SSB Committee on International Relations, in South American symposium on space research, Buenos Aires, December 1960.

17. Coordination of U. S. contributions to COSPAR-sponsored space biology discussion, Moscow, August 1961.

18. Planning for fifth meeting of COSPAR, and associated symposium on results of space research, in Washington, May 1962.

19. Continuous liaison, advice and assistance to NASA on development and conduct of NASA international space science program.

APPENDIX B

Original Ad Hoc Committees of the Space Science Board (August 3, 1958)

1. Geochemistry of Space and Exploration of Moon and Planets -- Chairman, Dr. Harold C. Urey, Professor of Chemistry, University of California, La Jolla; Vice Chairman, Dr. Harrison S. Brown, Professor of Geochemistry, California Institute of Technology.

2. Astronomy and Radio Astronomy -- Chairman, Dr. Leo Goldberg, Chairman, Department of Astronomy, University of Michigan.

3. Future Vehicular Development (Beyond vehicles immediately available and including possible space stations and interplanetary vehicles for scientific research) -- Chairman, Dr. Donald F. Hornig, Professor of Chemistry, Princeton University.

4. International Relations Field (Co-ordination with International Council of Scientific Unions and other national scientific bodies on problems in international sharing of payloads, international cooperation in space activities and advice on the formulation and effects of regulatory policies) -- Chairman, Dr. W. A. Noyes, Dean, College of Arts and Science, University of Rochester.

5. Immediate Problems (Space laboratories, orbits, currently feasible research projects, and liaison with the Technical Panel on the Earth Satellite Program of the U.S. National Committee for the International Geophysical Year during terminal phases of IGY) -- Chairman, Dr. R. W. Porter, Chairman of the USNC-IGY Technical Panel on the Earth Satellite Program, and Consultant - Communication and Control, Engineering Services, General Electric Company, New York.

6. Space Projects (Analysis of advanced space research proposals and long-range planning) -- Chairman, Dr. Bruno B. Rossi, Professor of Physics, Massachusetts Institute of Technology.

7. Ionosphere (Experiments pertaining to auroral and ionospheric effects, including whistlers and special propagation phenomena) -- Chairman, Mr. A. A. Shapley, Physicist, National Bureau of Standards, Boulder, Colorado.

8. Physics of Fields and Particles in Space -- Chairman, Dr. John A. Simpson, Professor of Physics, University of Chicago; Vice-Chairman, Dr. James A. Van Allen, Head, Department of Physics, State University of Iowa.

9. Future Engineering Development Beyond Available Facilities (Telecommunications, telemetry, guidance, environmental conditions and advanced laboratory requirements) -- Chairman, Dr. O. G. Villard, Jr., Professor of Electrical Engineering, Stanford University.

10. Meteorological Aspects of Satellites and Space Research -- Chairman, Dr. Harry Wexler, Director of Meteorological Research, U. S. Weather Bureau.

11. Psychological and Biological Research -- Chairman, Dr. H. Keffer Hartline, Biophysics Section, Rockefeller Institute for Medical Research; Vice-Chairman, Dr. S. S. Stevens, Professor of Psychology, Harvard University.

A twelfth committee, on Geodesy, will be chaired by a Board member still to be selected.

APPENDIX C

Letter from Dr. Detlev Bronk, President, National Academy of Sciences, to Dr. Lloyd V. Berkner, June 26, 1958

National Academy of Sciences
National Research Council
2101 Constitution Avenue,
Washington 25, D.C.

26 June 1958

Dear Dr. Berkner:

I am glad to express to you the great satisfaction taken by the officers of the Academy-Research Council in your acceptance of the responsibilities of the chairmanship of the new Space Science Board. We feel that the formation of this Board can have especial significance for science as we face the challenge and adventure of the new steps into space that are surely and swiftly on the way.

It is my hope that the Board will give the fullest possible attention to every aspect of space science, including both the physical and the life sciences. I believe that we have a unique opportunity to bring together scientists from many fields to survey in concert the problems, the opportunities, and the implications of man's advance into space, and to find ways to further a wise and vigorous national scientific program in this field.

We have talked of the main task of the Board in three parts - the immediate program, the long-range program, and the international aspects of both. In all three we shall look to the Board to be the focus of the interests and responsibilities of the Academy-Research Council in space science; to establish necessary relationships with civilian science and with governmental scientific activities, particularly the proposed new Space Agency, the National Science Foundation, and the Advanced Research Projects Agency; to represent the Academy-Research Council in our international relations in this field on behalf of American science and scientists; to seek ways to stimulate needed research; to promote necessary coordination of scientific effort; and to provide such advice and recommendations to appropriate individuals and agencies with regard to space science as may in the Board's judgment be desirable.

As we have already agreed, the Board is intended to be an advisory, consultative, correlating, evaluating body and not an operating agency in the field of space science. It should avoid responsibility as a Board for the conduct of any programs of space research and for the formulation of budgets relative thereto. Advice to agencies properly responsible for these matters, on the other hand, would be within its purview to provide.

You should feel free, of course, to establish such committees and other sub-groups as the Board may find necessary, under our usual procedures.

With my cordial good wishes and appreciation, I am

Yours sincerely,

Detlev W. Bronk
President

Dr. Lloyd V. Berkner, President
Associated Universities, Inc.
10 Columbus Circle
New York 19, N. Y.

APPENDIX D

Letter from Dr. Richard Porter, Transmitting Compilation of Proposed Space-Science Experiments, to Dr. Lloyd V. Berkner, July 18, 1958

July 18, 1958

Dr. Lloyd V. Berkner
Vice President and President
Associated Universities, Inc.
American Geophysical Union
10 Columbus Circle
New York 19, New York

Dear Dr. Berkner:

As requested I have, together with several of my associates from the I.G.Y. Satellite Panel, attempted to outline a continuing program of specific experiments relating directly, or in a few cases indirectly but significantly, to space science as I conceive it. It is believed that all of the proposed experiments could be made ready for flight within the period 1958-1960 if the necessary decisions were made promptly and if the available experience were efficiently applied. Although satellite tests were emphasized in collecting the ideas and information on which this report is based, it will be noted that some experiments in high-altitude rockets and other vehicles are recommended. The latter are not complete, and should be supplemented by other services such as that being made by Dr. Van Allen for this Board.

It is emphasized that this is an outline for budgetary purposes only. The estimates are the best possible in the available time but may be inaccurate in detail; however it is believed that they will be useful in establishing the general magnitude and expected cost of the work to be done.

It has been assumed that the Space Science Board is concerned only with the utilization of high-altitude rockets and space vehicles for basic scientific experiments and with associated work in other vehicles or in the laboratory which may be necessary to prepare for such experiments. The Board is not directly concerned with scientific or engineering work relating to the development of the vehicles themselves, nor to their utilization for commercial or military purposes. The

budgetary estimates do not include the cost of the launching vehicles or operations (except in the case of the balloons and rocketsondes), nor the cost of general purpose tracking and computation. Also not included in most of the budgetary estimates is the cost of the satellite structure, package engineering, spinning or stabilizing equipment and environmental testing. An additional cost roughly equal to the costs shown here should be added for such equipment and activity.

It is recommended that the Board first screen this list of experiments to select at least a few for which the feasibility, desirability, method, objectives, and selection of contractor are fairly obvious. In this category I would recommend NRL and Varian for the "light-pumping" magnetometer, MIT and National for the atomic clock, MIT for the self-luminous satellite, NACA for the large expandable satellite, University of Wisconsin for directional bolometers, and possibly a few others. Grants or contracts large enough to get these projects started or to keep them going at optimum rate should be recommended as immediately urgent.

In the other cases, it is recommended that the Board assign to appropriate committees of the Board the job of writing a better description of each desired experiment and then request all potentially interested agencies to prepare firm proposals. These proposals should then be evaluated on the basis of their content, experience of proposer, reputation for competence, understanding of the problem, facilities, other work load, etc., in order to select the best agency to be recommended for the grant or contract. I sincerely regret the haste with which this report was prepared; however it is my understanding that the Board desires that today's deadline be met even if it is necessary to do so with a far from perfect program outline. Under these conditions it is particularly important to remember that this information is suitable for budgetary purposes only, and should not under any circumstances be used as a final definitized program.

Very truly yours,

Dr. Richard Porter

RWP:mb
attachment

APPENDIX E

October 12, 1959

WORK REQUEST TO THE SPACE SCIENCE BOARD
From The
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

1. Long Range Planning

The National Aeronautics and Space Administration would like to have from the Space Science Board a continuing input of thoughts, ideas, and recommendations on the broad overall objectives, and the course that the space science activities in the United States should take. A prime question is: What are the basic philosophical objectives that should underlie the space sciences activities and program? Guiding principles are needed, rather than a detailed program formulation, which must be worked up in the NASA in consideration of a variety of factors, such as budget, availability of rockets, testing facilities, the balanced program emphasis between space sciences and other NASA activities, and so forth.

The following several paragraphs include some of the NASA thinking on the overall problem and question.

Any program is naturally composed of individual tasks that stem from the ideas and activities of the individual workers. In the case of the space sciences program these tasks are generally in the form of a rocket, satellite, or space probe experiment, and occasionally may be a related or supporting theoretical or laboratory investigation. These individual tasks are themselves best described in terms of the scientific disciplines in which they fall. Sometimes groups of tasks are gathered together into convenient packages for management or budgeting purposes.

But underlying the science program there should be a philosophical pattern that ties the various tasks together into a coherent and unified program, and which provides a compelling motivation that in itself can be accepted as adequate justification for the program. The underlying philosophy and basic motivation should be such that (in addition to the scientific specialists themselves who are working in

the field, and who would naturally approve) the scientific community in general would feel the necessity of supporting the program in principle, that the Government recognize the desirability and necessity for the program, and that the public accept the value of the program and support it.

One such basic philosophical objective might be to learn as much as possible about the earth, its atmosphere, and its environs. The idea here would be to put man in a position of understanding thoroughly the planet on which he lives. This is a worthy objective, one that may be expected to lead to both scientific and practical benefits. One may in all conscience ask the people of the United States to support such an objective. It is in fact, the very motivation that underlay the International Geophysical Year. In the area of space science such an objective would call for a broad and substantial program.

A somewhat broader philosphical basis for a space science program might be to learn as much as possible about the solar system, with particular emphasis upon solar terrestrial relationships. Since the sun is the primary source of energy for activity on the earth, in fact the very basis of man's ability to exist on the earth, a vigorous program directed at obtaining a thorough understanding of solar terrestrial relationships closely concerns the daily interests of mankind.

Another, and very exciting, philosophical basis for a space science program would be to learn as much as possible about the behavior of terrestrial life forms in space and under the conditions of space flight, and to seek out extraterrestrial life. The philosophical implications of a discovery that life does indeed exist elsewhere than on earth are tremendous, and surely of interest to the entire world, as well as to the scientist.

Finally, one might set as one objective of a space science program, a concerted search for the fundamental nature of the universe, of its origin, and of the origins of the bodies within it, including the sun and earth. Included here would be the search for experimental and observational evidence that could be used to seek out the fundamental nature of gravitational forces, or to determine the relationships between electromagnetic and gravitational fields, for example.

The NASA would appreciate having from the Space Science Board a continuing input on what should be the philosphical guidelines to use in building up the NASA space science program. Are those briefly stated above appropriate? Are there better ones? Has anything been left out? Where should the initial program emphasis lie? Should all of the above philosphical objectives be pursued vigorously simultaneously, or should there be some time phasing of the pursuit of the different objectives? What should be the broad lines of attack (a) to start, (b) after 5 years, (c) even later?

2. Discipline Planning

The strength of a scientific research program rests on good ideas and properly conducted experiments. The individual scientists are the source of both of these. The various discipline committees of the Space Science Board can serve a valuable function as a forum for discussion, and as a stimulus to the scientific community in their respective disciplines. To NASA the most valuable product of the Space Science Board committees would be a continuing outpouring of ideas for individual experiments, broad lines of attack, and relative emphases, all properly related to broad philosophical objectives as discussed above. NASA would also appreciate being informed of the names of scientists who would be interested in participating in the program. (In this connection NASA would, of course, undertake to honor and protect the rights of the individual scientists submitting original ideas for research.)

NASA would find such an input from the different committees of great value in the detailed formulation of the NASA national space sciences program. In this connection, it may be of value, from time to time, to call upon individual Space Science Board committees to meet at NASA for a working session to consider with the NASA space sciences staff specific problems of program planning.

3. International Programs

The NASA wishes to establish both the fact and the posture of a sound and substantive program of international cooperation in space research. To this end, NASA proposes to utilize all appropriate media. The ICSU Committee on Space Research (COSPAR) is regarded as a particularly appropriate medium for this purpose. In keeping with the U.S. tradition of maintaining contact with international scientific bodies through the U.S. National Academy of Sciences, NASA would like to maintain contact with COSPAR through the NAS and its Space Science Board.

NASA anticipates that COSPAR will serve as a focal point and means of suitable endorsement for cooperative activities in space research, as a forum for scientific discussion, and as a means of stimulating scientific interest and participation in space research. It is understood that COSPAR will not be an operating group.

NASA will undertake, through the Space Science Board, to keep COSPAR informed of the U. S. space science program and its scientific results. NASA will look forward to having the thoughts, ideas and suggestions of COSPAR in the area of space research. It is hoped that the Space Science Board will act to stimulate and transmit such contributions.

NASA presently contemplates two types of cooperation in developing its international program. The first involves bilateral arrangements in which each participant meets the costs of its own contributions, so that there is no interchange of funds; however, there is no requirement that the contributions of the different participants be equal. Where such cooperative projects involve sizeable efforts and sums of money, the agreements between technical agencies must ultimately be formulated in government-to-government agreements. COSPAR's contribution to such cooperation would come in the form of stimulus, comment, general aegis, and assistance in disseminating information as desirable.

The second type of cooperation involves the participation of scientists abroad in NASA experiments where such participation is possible merely by exercise of their own efforts, as in ordinary ground base applications. Such cooperation will, however, require adequate information. It is to be hoped that the Space Science Board will devote considerable thought and effort to the establishment, through COSPAR, of effective and rapid channels of communication to facilitate the types of cooperation described above.

4. Data and Results

The Space Science Board could provide a most useful service by arranging to continue the operation and functioning of the World Data Center A for Rockets and Satellites after the close of the International Geophysical Cooperation - 1959. NASA would be happy to discuss the possibility of defraying the costs of this Center. NASA would also undertake to forward to the Center the results and data obtained from the space sciences basic research program.

As part of the Center activity, it would be of great value to have a continuing literature search and abstracting activity in the field of space research, coordinating and supplementing other similar activities. Timely reports of current activities and results from rockets, satellites, and space probes would be of value to the scientific community, and also to NASA operations. Such an effort should cover not only U.S. activities but also those of other countries.

APPENDIX F

Memorandum from Hugh Odishaw to SSB Committee Chairmen and Members, February 5, 1960

Space Science Board
National Academy of Sciences
2101 Constitution Avenue
Washington 25, D. C.

FOR OFFICIAL SSB USE ONLY

February 5, 1960

MEMORANDUM - SSB-139

TO: SSB Committee Chairmen and Members

FROM: Hugh Odishaw

SUBJECT: Task before SSB

What should be the nature and scope of the U. S. space program over the coming years? The present basic task of the Board is to answer this question. The government has requested SSB assistance in this area.

While the Board has made major contributions to the national space effort through its recommendations in the past, these recommendations have been to some extent ad hoc and short range -- necessarily so because (i) space science is relative new, (ii) the vehicle problems have been recalcitrant, (iii) NASA is a recent entity, and (iv) policy and budget determinations have appreciable time lags.

The Board has a unique opportunity to affect policy and budgets at this time. Both NASA (see Attachment B and C) and the President's Science Advisory Committee invite assistance. The problem is difficult because the number of unknowns is large: for this reason a unifying point of departure is crucial if the Board's recommendations are to be meaningful. For this purpose, the following assumption is submitted as the premise upon which the Board's policy, program, and (implicitly) budget recomendations are to be made:

That the national space effort in the period 1970-80 provides the conceptual basis for working back to what should be done and achieved in the decade of the 1960's.

Recommdations as to the nature of the 1970-80 effort are requested below, but this assumption appears necessary for examining the 1960 decade. One can speculate as follows about this assumption: that in the 1970-80 period the exploration of the planets will be under way using vehicles with payloads of some 50 tons, capable of returning to Earth, involving total costs per venture of some $250 millions each. Perhaps ten such vehicles will be fabricated for use during the 1970's. In the light of this general picture, the Committees are asked to consider sections (1) and (2) of this memorandum.

1. The Decade 1970-1980

Assuming vehicles of the above capability and of course taking for granted adequate trajectory and orbit controls, stabilization, soft-landing and return capacity from moon and planets, then what is needed is the following:

Definition of major scientific objectives by both manned and unmanned spacecraft in the scientific exploration and study of the solar system and the interplanetary medium.

2. The Decade 1960-1970

In the light of the above definition, consider what should be done in the decade 1960-70 so as to maximize the value of the above effort in the following decade (1970-80).

2.1 The program in being. NASA representatives have been asked to review for the SSB Committees at their next meetings vehicle capabilities, schedules, and experimental payloads. Consider this review in terms of meaning and value of these experiments per se and for further experiments in the 1960's. Consider also problems of order and of compatibility of experiments planned for each vehicle.

2.2 The program for the later 1960's (i.e. 1962-1970). Project the experiments that should be undertaken (including background research), their order, etc. Such parameters as the following should be considered:

(i) Optimum order and schedule of launching for each experiment.
(ii) Orbit or trajectory requirements; their subsequent adjustment or stabilization.
(iii) Requirements for attitude adjustment or stabilization of payload package.
(iv) Requirements for hard and soft landings.
(v) Estimated payload requirements.
(vi) Mutual compatibility of experiments in same payload.

(vii) Requirements for additional ground-based facilities -- e.g., engineering, tracking, data analysis.

(viii) Requirements for fundamental research or technological developments necessary to support these space science experiments (in this connection, also see Attachment F from NSF which summarizes current NSF support for basic research relevant to space science).

If the SSB and its Committees, within the next three months can assess the 1960's, in as specific terms as possible as suggested in items (i) through (viii) above, profound influence can be exercised on the nature of the U. S. space effort.

3. International Programs

Academy and Board participation in international cooperation is via participation in the Committee on Space Research (COSPAR). Committees are requested to give consideration to the types of research programs which can profitably be fostered through COSPAR and to make suggestions for international cooperation which the Academy should recommend to COSPAR and NASA.

* * * * * * * * * * *

Committee chairman are asked to submit an interim report on committee findings in the above areas at the March 10-12 SSB meeting. This report should be as detailed as possible, consistent with the status of committee deliberations. Committee attention is directed to the last paragraph of Dr. Dryden's letter (Attachment C) of January 13, 1960, which requests an "initial input within the next quarter of the year." The Board must respond explicitly to this request by April 1 with concrete recommendations for the planetary and interplanetary experiments in each scientific discipline which should be undertaken over the next three to five years.

* * * * * * * * * * *

Attachments:

A. Schedule of committee meetings
B. NASA Work Request to the SSB
C. Letter January 13, 1960, from Dr. H. L. Dryden, Deputy Administrator, NASA, requesting SSB recommendations on planetary program and Chairman's response of January 26
D. Summary of prior committee program recommendations for space experiments (NASA space science funding)
E. Schedule of space vehicles and their capabilities
F. NSF Report: Programs in Base Science Related to Space Sciences

APPENDIX G

Man's Role in the National Space Program: Report by the Space Science Board, March 1961

SPACE SCIENCE BOARD
National Academy of Sciences
2101 Constitution Avenue
Washington 25, D. C.

Man's Role in The National Space Program

At its meeting on February 10 and 11, 1961, the Space Science Board gave particular consideration to the role of man in space in the national space science program. As a result of these deliberations the Board concluded that scientific exploration of the Moon and planets should be clearly stated as the ultimate objective of the U.S. space program for the foreseeable future. This objective should be promptly adopted as the official goal of the United States space program and clearly announced, discussed and supported. In addition, it should be stressed that the understanding of space, of solving problems of manned space exploration, and of development of applications of space science for man's welfare.

The Board concluded that it is not now possible to decide whether man will be able to accompany early expeditions to the Moon and planets. Many intermediate problems remain to be solved. However, the Board strongly emphasized that planning for scientific exploration of the Moon and planets must at once be developed on the premise that man will be included. Failure to adopt and develop our national program upon this premise will inevitably prevent man's inclusion, and every effort should be made to establish the feasibility of manned space flight at the earliest opportunity.

From a scientific standpoint, there seems little room for dissent that man's participation in the exploration of the Moon and planets will be essential, if and when it becomes technologically feasible to include

him. Man can contribute critical elements of scientific judgment and discrimination in conducting the scientific exploration of these bodies which can never be fully supplied by his instruments, however complex and sophisticated they may become. Thus, carefully planned and executed manned scientific expeditions will inevitably be the more fruitful. Moreover, the very technical problems of control at very great distances, involving substantial time delays in command signal reception, may make perfection of planetary experiments impossible without manned controls on the vehicles.

There is also another aspect of planning this country's program for scientific exploration of the Moon and planets which is not widely appreciated. In the Board's view, the scale of effort and the spacecraft size and complexity required for manned scientific exploration of these bodies is unlikely to be greatly different from that required to carry out the program by instruments alone. In broad terms, the primary scientific goals of this program are immense: a better understanding of the origins of the solar system and the universe, the investigation of the existence of life on other planets and, potentially, an understanding of the origin of life itself. In terms of conducting this program a great variety of very intricate instruments (including large amounts of auxiliary equipment, such as high-powered transmitters, long-lived power supplies, electronics for remote control of instruments and, at least, partial data processing) will be required. It seems obvious that the ultimate investigations will involve spacecraft whether manned or unmanned, ranging to the order of hundreds of tons so that the scale of the vehicle program in either case will differ little in its magnitude.

Important supporting considerations are essential to realization of these concepts:

(a) Development of new generations of space vehicles, uniquely designed for use in space research and not adaptations of military rockets, must proceed with sufficient priority to ensure that reliable vehicles of adequate thrust are available for lunar and planetary research. This program should also include development of nuclear stages as rapidly as possible.

(b) Broad programs designed to determine man's physiological and psychological ability to adapt to space flight must likewise be pushed as rapidly as possible. However, planning for "manned" scientific exploration of the Moon and the planets should be consummated only as fast as possible consistant with the development of all relevant information. The program should not be undertaken on a crash basis which fails to given reasonable attention to assurance of success or tries to by-pass the orderly study of all relevant problems.

(c) Consideration should be given soon to the training of scientific specialists for spacecraft flights so that they can conduct or accompany manned expeditions to the Moon and planets.

The Board strongly urges official adoption and public announcement of the foregoing policy and concepts by the U.S. government. Furthermore, while the Board has here stressed the importance of this policy as a scientific goal, it is not unaware of the great importance of other factors associated with a United States man in space program. One of these factors is, of course, the sense of national leadership emergent from bold and imaginative U. S. space activity. Second, the members of the Board as individuals regard man's exploration of the Moon and planets as potentially the greatest inspirational venture of this century and one in which the entire world can share; inherent here are great and fundamental philosophical and spiritual values which find a response in man's questing spirit and his intellectual self-realization. Elaboration of these factors is not the purpose of this document. Nevertheless, the members of the Board fully recognize their parallel importance with the scientific goals and believe that they should not be neglected in seeking public appreciation and acceptance of the program.

APPENDIX H

NATIONAL GOALS IN SPACE: 1971-1985, STATEMENT BY THE SPACE SCIENCE BOARD, OCTOBER 28, 1964

Statement of the Space Science Board

of the

National Academy of Sciences

on

National Goals in Space, 1971-1985

October 28, 1964

1. Preamble

The establishment of a specific goals for the national space effort from about 1971 to 1985 would serve to sharpen national objectives and to focus energies. Such a goal is desirable for the decade or so after Apollo, just as it was when President Kennedy designated a manned lunar landing as the target for the current decade. But the very progress that the Nation has made in manned space missions, in technology through the development of more powerful space vehicles and associated devices, in applications such as communications and cloud cover reconnaissance, and in scientific research where the harvest has already been rich and varied: this very progress makes it increasingly difficult to specify categorically a single target. Moreover the relationships among these areas -- manned missions, technology, application, and research -- grow more intimate with each day and with each achievement. Thus any goal specified for the '70s and early '80s must satisfy the requirement that it promises to contribute most effectively and economically to these related areas of interest.

Accordingly, the Space Science Board of the National Academy of Sciences designates the exploration of the nearer planets as the most rewarding goal on which to focus national attention for the ten to fifteen years following manned lunar landing.

The primary goal of the national space program in the exploration of the planets is Mars: it is one of the nearer planets (and hence relatively accessible); as a planet, its biological, physical, chemical, geophysical, and geological properties are at least as interesting as those of any of any of the other planets; of even greater significance and excitement to mankind, it affords the most likely prospect of bearing life.

The exploration should be carried out initially by unmanned vehicles to further our knowledge of the Martian environment. At the same time the

solution of difficult biomedical and bioengineering problems should proceed at a measured pace, so that we shall be ready for manned planetary exploration by 1985. Alternative goals for 1971-1985 - i.e., extensive manned lunar exploration including lunar base construction and major manned orbiting space station and laboratory programs - have sufficient merit to warrant significant programs, but are not regarded as primary because they have far less scientific importance.

Thus, the Board would hope that after initial landing missions of the Apollo program, manned trips to the Moon would continue in addition to the major effort on the investigation of Mars. Such lunar ventures would offer opportunities for return of samples in a systematic way and provide for continuity and variety in the transmissions of automated lunar stations. Any manned orbiting laboratory program to be conducted during this period should emphasize development and improvement of capability to send men to and from such stations. This capability would not only be significant in itself, but would also develop rescue capability for other manned missions.

Since the primary purpose of space exploration is the acquisition of knowledge relating to the solar system, adequate programs should continue to be directed toward the physics and chemistry of space, the Sun, the upper atmosphere of the Earth, and astronomy, not only optical and radio but now also X-ray and gamma-ray. Such programs must characterize the remaining years of this decade and continue into the subsequent epoch by virtue of their benefits to man in the increase of knowledge, the promise of eventual technological applications, and the support of manned ventures of all succeeding decades.

Mars as a goal for unmanned exploration in the '70s, followed by manned missions as their more complex problems have suitable time for solution, would serve also to direct the nation's energies in the development of increasingly useful space systems. A family of such systems, consisting of small, inexpensive lower-atmosphere rockets, upper-atmosphere

sounding rockets, space probes of varying ranges and payloads, spacecraft of varying planetary payloads, and space systems for manned ventures, is needed now and will be needed for many decades. Orderly development of these tools is crucial both for successively more difficult missions and for reliability and economy. Thus, the manned lunar program of this decade will provide for the unmanned exploration of Mars, time will be available to develop the more complex systems for man's ventures beyond the Moon.

Another aspect of technology that requires continued, parallel activity deals with the applications of science in communications, meteorology, and geodesy. These (witness the several communication satellites and the Tiros and Nimbus systems) have progressed with remarkable speed and success. Although the field merits continued and increased attention for practical reasons alone, scientific values are also involved in some of these areas, as well as implications for manned exploration.

* * *

The argument for unmanned investigation of Mars as the major effort for the 1971-1985 period is not presented solely in the interests of pure research. The Board takes for granted that broad, multi-faceted national interests lie behind an effective space program; the Board has long and consistently taken this view. The argument for unmanned investigation <u>is</u> an argument for the pursuit in an orderly way of what now appear to be the most rewarding objectives. Such a program would be planned to (1) capitalize upon each stage of technological capability, (2) yield tangible, meaningful results at appropriate intervals with no potentially critical gap, (3) secure environmental data essential to manned ventures, and (4) provide time for proper development of extended manned activities in space.

2. National Goals in Space, 1971-1985

Progress in the Apollo program has led the Space Science Board to review the program recommendations made to the Government in March 1961 when the Board recommended:

> "that scientific exploration of the Moon and planets should be clearly stated as the ultimate objective of the U. S. space program for the foreseeable future. This objective should be promptly adopted as the official goal of the United States space program and clearly announced, discussed and supported. In addition, it should be stressed that the United States will continue to press toward a thorough scientific understanding of space, of solving problems of manned space exploration, and of development of applications of space science for man's welfare."

The scientific exploration of the Moon is only the first step in a continuing program necessary for the understanding of space and for the difficult exploration of the planets to follow; it is a first step now in sight. This program has resulted in the development of significant technological capabilities which make it wise now (1) to plan for the utilization of this capability and (2) to raise national sights to the next step.

The Saturn class of vehicles, developed for Apollo, provide effective tools for early, unmanned planetary exploration. The scientific, engineering, and production capabilities created for Apollo, both inside and outside government laboratories, will soon be available as the Apollo requirements for this support decrease, even should this program encounter unforeseen delays. We urge that the next goal be sufficiently advanced, sufficiently exciting, and sufficiently rewarding to sieze the imagination of men everywhere. It should also be one that takes advantage of, and indeed sustains, this nation's leadership in scientific space exploration.

In adopting the major national space goal and in outlining the accompanying program the Board has considered three basic questions: (i) What program will produce the most significant results in the next decade or so? (ii) How can the nation most intelligently build on Apollo achievements while prepared to accept unforeseen delays? (iii) How can an uninterrupted flow of meaingful results be ensured over the next 20 years?

First, while a post-Apollo, manned lunar follow-up has much value, the Board believes that the ultimate values of planetary investigation are greater. Scientific results from a high-priority, unmanned planetary program (with emphasis on Mars) will contribute to expansion of knowledge over a broader field. At the same time, however, a suitable post-Apollo manned lunar effort would provide for an orderly return of samples and for the maintenance of radio transmissions from automated instruments. Although such a program has very substantial scientific value, the question is one of emphasis. Much the same reasoning applies to the Board's views on manned earth-orbiting laboratories, which also merit significant effort but in proper proportion to the primary emphasis on Mars and the other planets.

Second, in considering how best to capitalize upon Apollo, we have repeatedly asked outselves the question: What are the results of space exploration that we seek as a nation? The answer is knowledge, and this means essentially scientific knowledge. One of the major achievements of the Apollo effort will be Saturn V. Consideration of capitalizing on Apollo suggests that Saturn V be used for the planetary goal as promptly as possible; such use of Saturn V would be most responsive to the question above. Indeed, this exploitation of Saturn V may well provide a most compelling justification for Apollo.

Third, should the manned lunar program (Apollo and/or post-Apollo) encounter unforeseen delays, the unmanned planetary effort would provide

a means of securing important new and tangible results, in a sustained fashion. This return the Board believes to be not only scientifically critical but also essential in fulfilling our responsibility to the nation for so large an enterprise.

Some of these points may be re-stated and amplified as follows:

(1) Planetary Exploration. The new goal for the period 1971-1985 should be scientific exploration of Mars and general planetary exploration primarily by unmanned probes, landers, and orbiters for scientific investigations. Mars is of great scientific interest first because it offers the best possibility in our solar system for shedding light on extraterrestrial life and, second because as a planet it is dimensionally quite comparable to our own. One of the most exciting questions, and in the view of many scientists the outstanding problem of our times, is whether or not living forms have developed on Mars. It may be that organic compounds of inorganic origin may be found on or near its surface; such compounds, the progenitors of life systems, could lead to an understanding of the origin of terrestrial life. It may be that forms of life radically different from our own may be discovered, different in their chemistry, different in their cell structure, and different in their metabolism. Or perhaps we may find fossil evidence of earlier Martian life when Mars may have had a denser atmosphere and conditions more favorable to biological processes. The discovery of any of these situations would be of enormous scientific interest and perhaps the most important discovery of space research in our generation.

Mars is also an object of great physical and geological interest. For example, how does it compare with the Earth? Is it differentiated, like the Earth? Does it have a magnetic field indicative of a molten core? Has it a crust differentiated from a mantle? Scientists are in the tantalizing position of trying to discover the general laws of planetary formation and evolution on the basis of one example - the Earth - plus deductions from meteorites. Other examples are essential, examples

roughly similar to the Earth, such as Mars or Venus or the larger satellites of Jupiter, as well as entirely different bodies, such as Jupiter itself, Saturn, or, on the other end of the scale, the comets and asteroids. The anticipation of gathering and analyzing data from them is as exciting to scientists - and in a large and hitherto underestimated measure, we believe, to mandkind - as if they had just been presented with a fresh and largely unknown Earth to explore. For a long time this exploration must rely on unmanned fly-bys, orbiters, and landers.

(2) Biological Research. Biomedical research and development must be vigorously pressed. In the view of the Space Science Board the ultimate scientific exploration of Mars will require that man be present when it becomes technologically feasible to include him. To see that this stipulation is true, it is only necessary to imagine how difficult exploring the Earth would be by remote instruments, in comparison with manned exploration. But this phase must be deferred until the biomedical problems of long journeys in space are solved. By and large, experimentation with man cannot be rushed; by and large, it must proceed at a measured pace. Moreover, there are several very important basic biological investigations, scientifically significant in themselves, that can be undertaken only in the space environment. Such work may also call for manned orbiting laboratories as well as unmanned vehicles.

(3) Astrophysical Research. New results in fundamental astrophysics must be closely followed for their value in keeping the scientific goals up to date. Ground-based observations have discovered massive objects radiating enormous amounts of energy - the so-called quasi-stellar radio sources (quasars). These observations in the visible and radio wavelengths suggest new consequences of the fundamental connection between the physics of the very large (relativity) and the physics of the very small (elementary particles). The recent discovery of localized X-ray sources by rocket observations further underlines the necessity for close cooperation between astrophysics and laboratory physics. As in the

case of the quasi-stellar radio sources, a further investigation may bring about a new view of cosmology. These new astronomical discoveries again emphasize the importance of looking out into the universe for insight into the fundamental nature of matter and energy.

Beyond the classical electromagnetic radiation there is a very real possibility of the detection of gravitational radiation. It is not yet possible to define a specific program in this field; however, the results from planned observations from the ground, from orbiting observatories, and from rockets may well require major emphasis on this subject in the near future. New results in this area could have the most profound influence on the future philosophical, and perhaps practical, developments of science.

(4) Continuation of the present Science and Applications Program. We urge that these varied programs be continued and suggest that our 1962 Review of Space Research is for the most part still pertinent. In recommending Martian exploration as the primary objective of the space program, the Board has taken into account the present NASA program in manned and unmanned scientific research in space, with its many important investigations, and the anticipation of its success and growth. For the scientist, the most important thing is that well organized and coordinated geophysical, astronomical, and biological researches must go on - for example, satellite, rocket, and ground-based investigations of the upper atmosphere, the magnetic fields and particle fluxes near the Earth and in interplanetary space, astronomical observations in a variety of spectral ranges of the planets, and Sun. None of these programs should be neglected; as a matter of fact, they continue to contain critical scientific objectives in themselves, and some are essential back-ups to lunar and Martian missions.

We invite attention to a number of suggestions for the scientific program as the vehicle capability and performance improve. A concomitant improvement in the performance of orbiting observatories and probes -

e.g., in precision of pointing stabilization, and guidance, all of which entail larger weight in orbit - opens up a wider range of scientific opportunity.

Improvement in the capability and stadardization of our vehicles should also permit us to consider probes reaching, for example, into the solar corona, out of the plane of the ecliptic, to a distance of 40-60 Astronomical Units from the Sun, and to Mercury and Jupiter for a closer examination of these planets.

The space science program, while directed toward the ultimate goal of Martian exploration, must be designed so that it can be modified to take advantage of new discoveries as they occur. Flexibility must be retained if the changing needs of science are to be accommodated. The Board expects to examine these long-range goals in more detail in the very near future.

It is also clear that the next generations of geodetic and navigation satellites should go forward. The Board believes that research meteorological and communications satellites (as distinct from operational units) will also continue to be of great importance. These prospects cannot be neglected because it may well be, for example, that man will be soon able to affect his weather at will.

(5) Alternatives to Planetary Exploration. The Board recommends that the goal of planetary exploration be prosecuted consistent with the decreasing demands of the manned lunar landing program on the assumption that the space program that the nation should support will remain at or above the present level. It is aware of two possible major alternatives to planetary exploration that could be supported by these funds: (i) extensive manned lunar exploration, including the construction of a lunar base and (ii) major manned orbiting space stations or laboratories. It is the Board's view that both these choices have scientific merit and should be developed on a relatively modest scale as our knowledge of

their scientific value grows, but as adjuncts to the program of scientific exploration of the planets rather than as primary goals in themselves.

3. Recommendations

Aware of the parallel criteria of scientific and intellectual importance and of significance to the national interest, the Board summarizes its recommendations on the primary national objectives in the field of space science for the 1971-1985 period as follows:

1. Exploration of the planets with particular emphasis on Mars

   (a) This objective includes both physical and biological investigations, and especially the search for extraterrestrial life.

   (b) The experimentation should be carried out largely by unmanned vehicles while the solution of difficult biomedical and bioengineering problems proceeds at a measured pace so that toward the end of this epoch (1985) we shall be ready for manned planetary exploration.

   (c) Alternatives to the Mars and planetary exploration goal - (i) extensive manned lunar exploration (possibly including lunar base construction) and (ii) major manned orbiting space station and laboratory program - are not regarded as primary goals, because they have less scientific significance. However, both have sufficient merit to warrant parallel programs but of lower priority.

2. An enhanced effort in basic astrophysical research aimed toward a better insight into the fundamental nature of matter and energy. Particular attention should be paid to observations in the far untraviolet and long radio wavelengths and in the X-ray and gamma-ray wavelengths because fundamental relationships might be discovered between the physics of the very large (relativity) and the physics of the very small (elementary particles). Attempts to observe gravitational radiation should also be supported and encouraged.

3. Continuing pursuit of other physical, astronomical, and biological investigations on a broad scientific front using sounding rockets, earth satellites, space probes, lunar orbiters, and lunar landers.

4. Continuing development of technical applications of space technology in the fields of communication, meteorology, geodesy, and navigation.

(a) Such work should be concentrated on basic technological development and on engineering demonstrations, but

(b) routine operational use of space systems in these fields should generally not be undertaken by NASA; instead, it should be assigned to the appropriate operating agency of the government or, as feasible, to private corporations.

APPENDIX I

RECOMMENDATIONS OF THE SPACE SCIENCE BOARD'S COMMITTEE ON INTERNATIONAL RELATIONS, SEPTEMBER 24, 1958

National Academy of Sciences
2101 Constitution Avenue N.W.
Washington 25, D. C.

FOR ACADEMY USE ONLY

9/24/58

Space Science Board

Committee on International Relations

Having considered the desirability of establishment by the ICSU of a Special Committee for Space Research, the Committee on International Relations of the Space Science Board makes the following recommendations:

1. The ICSU should establish a Special Committee for Space Research.

2. Primary purpose of the Committee should be to provide a suitable mechanism within the scientific community cooperatively to exploit space probes and satellites of all kinds and to foster cooperative exchange of the resulting data.

3. The Committee should serve also as a forum for program considerations.

4. i. The Committee should be composed of representatives from the satellite-launching nations, the nations with major rocketry programs, and some representation, perhaps on a rotating basis, from those nations participating in tracking activities, In addition, the Committee should include representation from the IAU, IUGG, URSI, IUPAP, IUBS, IUPS, and IUPAC.

   ii. The Committee's executive body should always include representatives of the satellite-launching nations.

   iii. The Committee's charter should be formulated by the Committee itself and submitted to the ICSU for approval.

5. i. The Committee should interest itself in UN actions with respect to space in order to maximize the area reserved for the scientific community, minimize UN incursions into scientific activities, and assure a reasonable regulatory framework.

ii. To permit the Committee to exert its best offices in this regard, it is of the utmost urgency that the Committee be established by ICSU prior to UN consideration of space matters.

APPENDIX J

SPACE PROBE STERILIZATION: SSB POLICY STATEMENT TO NASA, AUGUST 5, 1963

SPACE SCIENCE BOARD
National Academy of Sciences
National Research Council
2101 Constitution Avenue
Washington, D. C.

August 5, 1963

SPACE PROBE STERILIZATION

During 1959 a special ad hoc group of the Space Science Board considered the subject of contamination of probes likely to impact the Moon or the planets. These considerations resulted in the adoption of a two-part recommendation which was transmitted to the Government in September 1959:

"(1) that an immediate study program be undertaken to determine sterilization requirements for space probes and to develop recommendations, compatible with present design and assembly processes, regarding necessary sterilization procedures;

(2) that procedures be immediately established and implemented to insure a complete inventory of all components of all space probes."

These recommendations formed the basis for studies of space vehicle sterilization by the National Aeronautics and Space Administration and resulted in NASA's general policy of "sterilizing, to the extent technically feasible, all space probes intended to pass in the near vicinity of or impact on the Moon or planets."

During the course of the 1962 Space Science Summer Study a working group of scientists and engineers together reviewed the three years of experience and reported its findings in "A Review of Space Research" (NAS-NRC Publication 1079, Chapter 10). As a result of this report and with additional information available to it, the Space Science Board has adopted a restatement of policy with regard to (1) lunar probes and (2) Mars probes.

The Moon

The lunar surface with its high temperatures, intense ultra-violet radiation, paucity of moisture, and high vacuum is a most unfavorable environment for proliferation of terrestrial organisms. Although some forms could survive in protected places, they would be relatively immobile. Lunar subsurface conditions, in contrast, are relatively unknown. However, except at the site of impact, deep subsurface contamination from a lunar landing appears highly unlikely. Even so, the lunar exploration programs to date, both U.S. and Russian, have undertaken to minimize contamination in order to avoid depositing terrestrial organisms on the Moon; both of the probes which have impacted on the Moon are believed to have carried only a relatively small number of microorganisms. Nevertheless the deposition of terrestrial contaminants (viable or not) over portions of the lunar surface seems nearly certain. While this introduction of organic substances of terrestrial origin into the lunar surface seems at present unavoidable, we believe it continues to be undesirable. Minimizing contamination by future lunar impactors remains an important consideration from the scientific viewpoint. The chief purposes here are to avoid possible distortion of chemical evidence (e.g. by microbial action) which may bear on conditions which preceded the volution of life and to preserve the deep layers uncontaminated for subsurface life-detection experiments.

In view of these considerations the Space Science Board recommends that the following policy be considered for spacecraft programmed to land on the Moon:

(i) Minimize contamination to the extent technically feasible. By appropriate selection of components (favoring those which are inherently sterile internally) and the use of subsurface sterilants it should be possible to achieve a cleanliness level to approximate that which prevails in most hospital surgery rooms.

(ii) Inventory all organic chemic al constituents. This will permit the interpretation of analytical results from future collections of lunar material.

(iii) Accord a low priority to life-detection experiments by remote devices on the lunar surface. A high priority should be attached to sampling the subsurface at points removed from the immediate vicinity of any landing site.

(iv) Undertake the development of a sterile drilling system to accompany an early Apollo mission to return an uncontaminated sample of the lunar subsoil. Samples aseptically

collected from this subsoil will be of both biological and geochemical interest. Should life exist on the Moon, it might be expected at some depth below the surface where temperatures never exceed 100°C and below the zone of ultraviolet radiation. Every effort should be made to keep this level free of contaminants until it can be sampled by drilling.

Mars

The planet Mars is by far the most probably extraterrestrial body in the solar system to be populated by forms of life. One of the most significant possible discoveries in space research, and perhaps even the most important, would be the finding of extraterrestrial life. Discovery of living organisms on Mars must depend on means of detection which could not be expected to distinguish between terrestrial contaminants and members of an indigenous Martian biota. Some terrestrial microorganisms are known to survive simulated Martian environmental conditions. Therefore the contamination of Mars through the impacting of nonsterile probes from the Earth could destroy an opportunity to carry out a meaningful search for life forms on Mars with remote detectors. This opportunity is unique and its loss would be a catastrophe: it is essential to preserve Mars until complete sterilization of the probes to land there has been achieved.

Moreover, should the initial life-detection experiments to be sent to Mars yield negative results, sterilization of Martian probes should not be abandoned automatically. There will remain scientific reasons for continuing to adhere rigidly to a policy of sterilization during the initial phases of sample collection from Martian surface and subsurface. If sterile, Mars will provide a unique opportunity to detect and analyze organic compounds of nonbiological origin in the Martian soil. Such studies of prebiological geochemistry, free from interference from living organisms, can supply important and otherwise not directly attainable information concerning the origins of life. Therefore contamination (introduction of viable terrestrial microorganisms) and pollution (introduction of significant amounts of terrestrial, albeit sterile, organic matter) are to be avoided until adequate soil sampling can be accomplished even if initial results from remote detectors suggest that Mars may have no biota.

In view of these considerations the Space Science Board recommends that the following policy be considered for spacecraft programmed to land on Mars:

(i) Accord the highest priority to the prevention of the biological contamination of Mars until sufficient information has been obtained about possible life

forms there so that further scientific studies will not be jeopardized. Recognition of this priority on the part of launching nations is in accord with their main scientific objectives, in contrast to a competition to be first in which these objectives might be forever sacrificed.

(ii) Establish and provide adequate support for an augmented research program to develop agents, methods and techniques for the sterilization of Martian probes. Such a research program should mobilize both biologists and engineers to insure successful development of practical sterilization procedures.

(iii) Inventory all organic chemical constituents. This is precautionary, but the lack of an inventory might make impossible the interpretation of analytical results from future collections of Martian material.

(iv) Cooperate fully with all other nations in the protection of Mars against premature biological contamination. The exchange of information and the possibility of a joint research project between scientists of the USSR and the U.S. should be explored.

(v) Strengthen the current research program for the development of the best possible life-detection experiments to insure the incorporation of a life-detection experiment in the first Mars lander. This is of extreme importance for otherwise we may succeed in the sterilization of Mars probes but fail to accomplish our true objectives.

BIBLIOGRAPHY

SELECTIVE BIBLIOGRAPHY

Public Documents

Emme, Eugene M. Aeronautics and Astronautics: An American Chronology of Science and Technology in the Exploration of Space, 1915-1960. Washington: National Aeronautics and Space Administration, 1961.

National Aeronautics and Space Administration. Aeronautical and Astronautical Events of 1961. Report of the National Aeronautics and Space Administration to the Committee on Science and Astronautics. U.S. House of Representatives, 87th Cong., 2nd Sess., 1962.

_____. Aeronautical and Astronautical Events of 1962. Report of the National Aeronautics and Space Administration to the Committee on Science and Astronautics. U.S. House of Representatives, 88th Cong., 1st Sess., 1963.

_____. Astronautics and Aeronautics, 1963. NASA SP-4004. Washington: National Aeronautics and Space Administration, 1964.

_____. Astronautics and Aeronautics, 1964. NASA SP-4005. Washington: National Aeronautics and Space Administration, 1965.

_____. First Semiannual Report to the Congress of the National Aeronautics and Space Administration. House Document No. 187, 86th Cong., 1st Sess., 1959.

U.S. House of Representatives, Committee on Astronautics and Space Exploration. The International Geophysical Year Space Research. House Document No. 88, 86th Cong., 1st Sess., 1959.

_____, Committee on Government Operations, Government Operations in Space. House Report No. 445, 89th Cong., 1st Sess., 1965.

U.S. Senate, Committee on Aeronautical and Space Sciences. Documents on International Aspects of the Exploration and Use of Outer Space, 1954-1962. Senate Document No. 18, 88th Cong., 1st Sess., 1963.

_____. International Cooperation and Organization for Outer Space. Senate Document No. 56, 89th Cong., 1st Sess., 1965.

_____. National Goals for the Post-Apollo Period. 89th Cong., 1st Sess., August 23, 24, and 25, 1965.

Books

Berkner, Lloyd V. The Scientific Age: The Impact of Science on Society. New Haven: Yale University Press, 1964.

Berkner, Lloyd V., and Odishaw, Hugh (eds.), Science in Space. New York: McGraw-Hill Book Company, Inc., 1961.

Cox, Donald W. America's New Policy Makers: The Scientists' Rise to Power. New York: Chilton Books, 1964.

Dupre, J. Stefan, and Lakoff, Sanford A. Science and the Nation: Policy and Politics. Englewood Cliffs: Prentice-Hall, Inc., 1962.

Lapp, Ralph E. The New Priesthood: The Scientific Elite and the Uses of Power. New York: Harper and Row, 1965.

Odishaw, Hugh (ed.) The Challenges of Space. Chicago: The University of Chicago Press, 1962.

Price, Don K. The Scientific Estate. Cambridge: Harvard University, 1965.

Rosholt, Robert L. An Administrative History of NASA, 1958-1963. NASA SP-4101. Washington: National Aeronautics and Space Administration, 1966.

Sullivan, Walter. Assault on the Unknown. New York: McGraw-Hill Book Company, 1961.

Van Dyke, Vernon. Pride and Power. Urbana: University of Illinois, 1964.

Wiesner, Jerome B. Where Scientists and Politics Meet. New York: McGraw-Hill Book Company, 1965.

Official Reports

American Association for the Advancement of Science. The Integrity of Science. A Report by the AAAS Committee on Science in the Promotion of Human Welfare. Washington: American Association for the Advancement of Science, 1964.

Hunsaker, J. C. Forty Years of Aeronautical Research. From the Smithsonian Report for 1955, pp. 241-271. Washington: Smithsonian Institution, 1956.

National Academy of Sciences. Annual Report, Fiscal Year 1958-1959. Washington: National Academy of Sciences. 1960.

National Aeronautics and Space Administration. Space Science and Applications Program. Washington: National Aeronautics and Space Administration, December 1965.

_____. Historical Sketch of NASA. NASA EP-29. Washington: National Aeronautics and Space Administration, 1965.

Newell, Homer E. Space Science and Applications Programs. A Report Presented to the Space Science Board. Washington: National Aeronautics and Space Administration, November 1964.

_____. Space Science and Applications Programs. A Report Presented to the Space Science Board. Washington: National Aeronautics and Space Administration, December 1965.

Space Science Board, Committee on Space Research (COSPAR): Directory of Organization and Members. Washington: National Academy of Sciences, 1966.

_____. Minutes. A Record of the Proceedings of all the Meetings of the Space Science Board. Washington: Space Science Board, 1958-1966.

_____. Report of Activities. A Report of the Activities of the Space Science Board. Washington: National Academy of Sciences, 1958-1963.

_____. Space Science Board and Committees: Membership. Washington: National Academy of Sciences, April 15, 1966.

_____. Space Research: Directions for the Future. A Report of the 1965 Summer Study. Washington: National Academy of Sciences, 1965.

_____. United States Space Science Program. A Report to COSPAR, Washington: National Academy of Sciences, 1962.

_____. United States Space Science Program. A Report to COSPAR. Washington: National Academy of Sciences, 1965.

U.S. President. U.S. Aeronautics and Space Activities, January 1 to December 31, 1958. A Report to Congress.

_____. U.S. Aeronautics and Space Activities, January 1 to December 31, 1959. A Report to Congress.

_____. U.S. Aeronautics and Space Activities, January 1 to December 31, 1960. A Report to Congress.

_____. United States Aeronautics and Space Activities, 1961. A Report to Congress.

_____. United States Aeronautics and Space Activities, 1962. A Report to Congress.

_____. United States Aeronautics and Space Activities, 1963. A Report to Congress.

_____. United States Aeronautics and Space Activities, 1964. A Report to Congress.

_____. United States Aeronautics and Space Activities, 1965. A Report to Congress.

Interviews

National Aeronautics and Space Administration. Personal interview with Margaret Beach, Space Science Steering Committee Secretariat, National Aeronautics and Space Administration, Washington, D. C., July 25, 1966.

_____. Personal interview with J. Allen Crocker, Deputy Director, Program Review and Resources, Office of Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C., July 25, 1966.

_____. Personal interview with Homer Newell, Associate Administrator for Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C., July 27, 1966.

_____. Personal interview with Jack Posner, Program Review and Resources, Office of Space Science and Applications, National Aeronautics and Space Administration, Washington, D. C., July 22, 1966.

_____. Personal interview with James E. Webb, Administrator, National Aeronautics and Space Administration, Washington, D. C., September 9, 1966.

Space Science Board. Personal interview with Hugh Odishaw, Executive Director, Space Science Board, National Academy of Sciences-National Research Council, Washington, D. C., August 2, 1966.

Articles and Periodicals

David, Heather. "Three-pronged Role Urged for NASA," Missiles and Rockets, January 14, 1963, p. 19.

Greenberg, D. S. "Space: Administration Official Says Some Harsh Things About Scientists Opposing Moon Landing," Science, January 22, 1965, p. 381.

Hines, William. "Scientist Corps Urged for Astronaut Program," The [Washington] Evening Star, June 12, 1963.

"Scientists Form Space Unit of 16," New York Times, August 3, 1958.

GPO 922-173